**Presenting the case for implementing entrustable professional activities (EPA) in Sport and Exercise Sciences teaching: Application and alignment to develop student competencies.**

Research Article

Keywords: *Higher Education, Pedagogic Development, Sport Sciences, Accreditation*

Dr. Eddie J. Bradleya\*, Dr. Lisa Boarda, Dr. David Archera, & Mikeala Morgansb

aFaculty of Health Sciences and Wellbeing, City Campus, University of Sunderland, Sunderland, SR1 3SD, United Kingdom.

bFaculty of Education and Society, St Peter’s Campus, University of Sunderland, Sunderland, SR1 3SD, United Kingdom.

\*Corresponding author. [eddie.bradley@sunderland.ac.uk](mailto:eddie.bradley@sunderland.ac.uk); ORCID: 0000-0003-3518-3305; Twitter: @DrEddieBradley

**Abstract**

Entrustable professional activities (EPA) are commonly integrated within competency frameworks across many healthcare curricula but are less evident in the training of Sport and Exercise Scientists. Equipping graduates with the key knowledge, skills and professional attributes to complete practical tasks competently with minimal supervision in the workplace is essential. Entrustable professional activities are an indicator of practical competency within a field of work, enabling students to independently display specific practical expertise in an authentic workplace setting. The aim of this paper is to describe how entrustable professional activities can be implemented into Sport and Exercise Sciences teaching in Higher Education. To guide the paper, a narrative review approach was utilised to identify current EPA frameworks and processes in use. A framework and competency matrix were developed based on the accreditation criteria of the British Association of Sport and Exercise Sciences (BASES) and implemented into an introductory module. The EPA framework was evaluated by asking students (n=47) to rank the importance of the competency action statements. The EPA framework was successfully used within a module and the framework was defined as a matrix, with statements aligned to a selection of expected graduate competencies, as EPAs were not related to specific tasks but were designed to cover the tests included in the module. EPAs offer a well-structured teaching and learning tool with clear alignment to the overall discipline of Sport and Exercise Sciences. EPAs may aid the professional development of key attributes and skills to produce work-ready Sport and Exercise Science graduates.

Keywords: *Higher Education, Pedagogic Development, Sport Sciences, Accreditation*

1. **Introduction**

Entrustable professional activities (EPA) are an indicator of practical competency within a field of work (Ten Cate, 2005). They are aligned to day to day operational tasks, often related to health and safety or specific skills within job roles and aim to enhance autonomy and reduce the burden for supervision in the workplace. According to Dreyfus and Dreyfus (1980), learners usually begin as novices for most skills and progress at an individual pace through training to reach a competent level. As they progress towards competency, the level of supervision decreases, and a threshold level of entrustment is achieved. In higher education, EPAs will recognise and document capabilities in a formal process that will improve employer confidence and enhance graduate prospects by developing work-readiness and provide quality assurance of graduate skills (Sleep & Reed, 2006). Therefore, embedded EPAs create a development pathway for all students and act as a pedagogic strategy to improve employability.

Established concepts and practice in Higher Education can adopt a model of learning that are more attuned to active learner participation in the learning process, rather than passive acquisition of knowledge. Learners can be co-creators of their learning content and activities, assessment criteria, and marking rubrics. This develops a stronger sense of belonging and deeper student-tutor relationships within an open and transparent community of practice, thus affirming their agency as 21st-century learners (Dawson, Cook, & Lambton, 2014; Gros & Lopez, 2016), that may produce ownership of development and enhance professionalism.

The British Association of Sport and Exercise Sciences (BASES) is the professional body overseeing sport and exercise sciences in the United Kingdom. The aim of the association is to drive excellence in sport and exercise science across three key themes of research, applied practical support, pedagogy, and the development of professional standards through supervision, accreditation, and endorsement. The outline for BASES Accreditation (https://www.bases.org.uk/sspage-professional\_development-accreditation\_and\_endorsement-bases\_accreditation.html) states that it is a professional standard to practitioners deemed necessary to practice safely and effectively, through the effective demonstration of skills, knowledge, and understanding of sport and exercise sciences principles in one of the three key sub-disciplines of biomechanics, physiology, or psychology, or from an interdisciplinary perspective. The criteria for accreditation are based on achieving and displaying competency within the chosen sub-discipline, with the competencies developed through an appropriate sport and exercise curriculum. Therefore, aligning the curriculum to the BASES accreditation through an EPA framework will facilitate teaching and learning, and the enhancement of professionalism within this academic field.

The aim of this paper was to describe the implementation of entrustable professional activities into the curriculum for Sport and Exercise Sciences in higher education, and to present the development of an EPA framework. Once the EPAs have been identified and defined, a matrix is created for each EPA, describing the competency domains, required knowledge and skills, alignment with the BASES Accreditation and methods of assessment and timeframe.

* 1. ***Competency-Based Medical Education***

Competency-based medical education (CBME) is a widely used approach for teaching undergraduate medical students globally. The approach has roots within the outcome-based education that arose in the 1970’s (Block, 1974) and is still widely used in higher education settings, often mapping to national accreditation standards for example the Outcomes for Graduates framework in the UK. Traditionally these competency frameworks have been applied to postgraduate training but more recently has been applied to undergraduate medical education (Harris et al. 2010). In the CMBE process, learning objectives set criteria to which programmes and modules are structured, with students’ knowledge and understanding defined against the generic objectives (Harden, 2002). This approach has been criticised as it does not consider the outcome of the learning process (Talbot, 2004), or can be vague and confusing (Guilbert, 2002). Where education programmes are required to deliver graduates who possess technical and professional skills that can be implemented autonomously in the workplace, it is beneficial to start with these required skills (outcomes) of the practising professional and work backwards to identify appropriate teaching channels to deliver the skills (ten Cate & Scheele, 2007). With clear outcomes and processes, the learning outcomes can then be defined that align with programme/module outcomes and national standards, if required.

In disciplines such as Sport and Exercise Sciences, where the ability to perform tasks safely and effectively is of paramount importance, development of an outcome-based educational approach seems most prudent. Competency-based education is important as it shifts the process from dispensing knowledge and developing understanding to acquiring skills and applying the knowledge (Carraccio et al., 2002; Iobst et al., 2010). This approach enables learners to perform tasks with increasing confidence as they progress through an undergraduate programme of study and into the workforce – developing their competency through reflection of their own learning. Whereby, self-reflection is an ongoing process in that students consider prior and current experiences, recognise how thoughts, behaviours, and emotions impact on development, and create changes in their learning frames of reference. CMBE is now generally accepted (Iobst et al., 2010) within the medical education setting but it is unclear how well it suits sports education.

The promotion of learner-centredness is concerned with developing student independence, creating a learning environment, ownership of their learning experience, and supporting life-long learning (Gruppen et al., 2016). Within CMBE, training should be clear with defined learning milestones to enable students to identify and track their progression through their medical training programme (Caverzagie et al., 2013). Whilst most traditional education curricula require students to complete a set of defined tasks and assessments per year of study, competency-based medical education provides flexibility to allow students develop the required level of competency at variable stages (Iobst et al., 2010; Loftus, 2016). This flexibility is an important element of this approach as the learning curve of students varies. Structuring modules to facilitate such flexibility is a challenge in traditional curricula and the change is usually required at team or faculty level to align teaching methods (Dath & Iobst, 2010; Iobst et al., 2010) or adapt to evolving national frameworks. However, as learner independence is a desired graduate attribute, implementing an educational philosophy that promotes its development should help reduce staff resistance. If practical applications of competency-based education are possible it will assist staff transition to a competency-based curricula.

* 1. ***Entrusted Professional Activities***

The area of entrustable professional activities has been developed and implemented across the healthcare sector. Ten Cate (2018) states that an EPA is unit of professional practice entrusted to a trainee once sufficient competence has been reached, and builds on competency-based training (Dewey, Jonker, ten Cate, & Turner, 2017; Loftus, 2016), where competencies are defined as observable and measurable actions (ten Cate, 2005). What separate EPAs beyond competencies is they relate to operational tasks that are required of the trainee in an authentic workplace setting where the recipient of the activity must trust the outcome. EPAs link the personal competencies to work-based actions (Meyer et al., 2019; Van Loon, Driessen, Teunissen, & Scheele, 2014) and it is likely that a person would be deemed adequately trained to perform the role if they were able to complete such actions with minimal or no supervision (Dewey et al., 2017; van Bockel et al., 2019; Weller et al., 2014).

EPAs are usually based upon professional frameworks with clear stages of competency development towards expertise in practice (Hauer et al., 2013; ten Cate & Scheele, 2007; ten Cate, 2013), enabling students to display specific practical expertise relevant to the role (Loftus, 2016). When the required level of competency is achieved, the student can be trusted to select and complete the appropriate task necessary (ten Cate, 2013; Wagner & Reeves, 2015). An EPA is not a singular entity but must incorporate abilities across domains of performance and apply such abilities as an integrated skill when required (Chen et al, 2015; Dewey et al., 2017). The domains must include specific task knowledge, but also professional skills such as communication, empathy, decision-making, and leadership (Pangaro & ten Cate, 2013) and ensure that the student assumes responsibility for performance and achieves task autonomy.

* 1. ***Issues with EPAs***

While entrustable professional activities are widely seen as a valuable and constructive education modality and an alternative to traditional CBME, concerns have been raised relating to the implementation within medical education (Krupat, 2018; Kwan, Crampton, Mogensen, Weaver, van der Vleuten, & Hu, 2016; O’Dowd, Lydon, O’Connor, Madden, & Byrne, 2019). These concerns relate to four areas: content and focus, measurement and assessment, suitability of medical EPAs, and the quality and standardisation of EPA development. Krupat (2018) and Kwan et al. (2016) both described how there is discord between clinicians’ interpretation of EPA structure and their application. For example, creating single EPAs for multiple tasks or vice versa, or the inclusion of EPAs not suitable across all levels. Similarly, a best fit is not necessarily available or described (O’Dowd, 2019), and this can lead to ad-hoc decisions (Kwan et al., 2016) which may limit the validity of the EPA. These content concerns are likely specific to the medical CORE EPAs defined by the Accreditation Council for Graduate Medical Education in the USA (Krupat, 2018) as this is the most common framework examined (Kwan et al., 2016), but they are legitimate issues that must be considered when constructing educational EPAs.

A broader criticism is directed at how EPAs are assessed using an apparent objective definition of task success with a subjective assessment of whether the trainee has achieved success (Crossley & Jolly, 2012; Krupat, 2018). While this introduces a potential measurement judgement that affects the usefulness of the EPA, the subjective aspect of decision-making is present in all forms of educational assessment. In fact, the advice provided by ten Cate et al. (2015) reinforces the point that decisions should be based on an assessor’s direct observation of the student or trainee. Furthermore, using specifically described anchors, such as those linked to the Wagner and Reeves (2015) criteria, that follow ten Cate’s design guidelines, facilitates judgement and improves effectiveness (Derbyshire & McDonald, 2004). It is therefore suitable to use anchors such as ‘no entrustment to complete’ and ‘completely unsupervised’ rather than ‘poor’ and ‘excellent’ as these are too vague. Dewey et al. (2017) highlight the need for the trainer or educator to be familiar with EPAs and to be able to make accurate assessment on student competence (Ericsson, Krampe, & Tesch-Romer, 1993; Iobst et al., 2010). Thus, incorporating a process of educating the academic staff in a position of delivering and assessing EPA in Sport and Exercise Sciences should be considered when developing it as a pedagogic approach.

* 1. ***Link to Sport and Exercise Sciences***

Professional standards are well established within healthcare and medicine (Chen et al., 2015). However, these are somewhat lacking in the field of Sport and Exercise Sciences despite sport and exercise science graduates often working alongside health professionals such as physiotherapists, where physical testing and interventions are applied to elicit physiological, psychological and biomechanical adaptations to create improvements in health and performance or prevent/treat injuries. Sport and exercise scientists must display practical skills that are aligned to the requirements of the job role whilst working in applied setting, where poor practical ability will at best lead to a waste of time or lack of professional trust, and worse lead to career-ending injury or elimination from a competition (Le Meur & Torres-Ronda, 2019). Ensuring students are equipped with the appropriate practical competencies that require a minimal level of supervision on entering the workforce is necessary to develop graduate prospects as these are key attributes sought with sport. Practitioners in this field frequently operate individually and without supervision and thus, the principles of competency-based education and entrustable professional activities would be valuable to guide Sport and Exercise Sciences education. In a scoping search of the literature using the databases Pubmed, Google Scholar, ScienceDirect, and SportDiscus, five papers were identified that included the key search terms of ‘entrustable professional activities’ or ‘competency-based education’ and ‘sport’ or ‘sport science’ or ‘sport and exercise science’ (Collins et al., 2015; Datta et al., 2021; Demers et al., 2006; Fletcher & Maher, 2013; Smith, 2019).

The paper by Collins et al. (2015) concerns competency-based education and ‘sport’ it mainly serves as an argument against competencies as the prime approach for developing scientists and coaches in sports roles. They state that competencies are too simple, vague, or contradictory to adequately account for the complex and varied situations sports support or coaching professionals encounter in their working environments. The authors suggest that we must include expertise-based approaches to support development to overcome these limitations. This viewpoint aligns with the purpose and structure of entrustable professional activities, that competencies are important but understanding the reason for need for competency and application is just as important, and EPA provide this extension in a higher education setting. They support this through stating the characteristics of expertise defined by Epstein and Hundert (2002) such as ‘knowledge structure’ and ‘reasoning processes’. The authors highlight how these differ from competencies but fail to acknowledge that achieving expertise requires time and is unlikely that the trainees will have been exposed to the level of learning for the required duration. As such, competencies provide the pillars of academic knowledge and skill that can be developed towards expertise, and entrustable professional activities provide the bridge between the two.

Fletcher and Maher (2013) present a case for using competencies within Sports Psychology support. They state that competencies are relevant and provide professional development as they enable the discipline and practitioners to be accountable. This is a clear benefit of competencies, in that they underpin skill and knowledge, and the authors relate this to the work of Epstein & Hundert (2002) but take a different viewpoint to Collins et al (2015) in that the definitions of Epstein & Hundert (2002) ‘captures the essence of competence’ (Fletcher & Maher, 2013, pg 267) rather than describing how competencies fail to achieve the complexities highlighted in the definitions. The paper develops and presents a conceptual model of competencies framework for Sports Psychology, the Competency Cube, that incorporates two competency domains and stages of development. The Sport Psychology specific framework includes similar components that are described in the medical EPA literature and it is possible to transfer elements of the framework into a broader Sport and Exercise Sciences framework.

Competency-based education was employed as the pedagogic rationale behind the development of a Canadian Baccalaureate in Sport Intervention undergraduate programme, as described by Demers et al (2006). The authors explain how, following on from a consultation period, it was identified that the programme of coach education required a professional element, that included more rigorous assessment procedures, and crucially, should have a curriculum based on competencies. The paper is very useful in delineating the process of course development with competencies in mind, highlighting design considerations and course element structure, it actually describes how experiential learning facilitates student development through competency-based education and problem-based learning, rather than define or describe competencies that students will be achieving through the programme or how these align to the professional requirements of coaches and educators.

Datta and colleagues (2021) describe their use of a five-step process to develop EPAs, milestones and portfolio in a sports medicine postgraduate medical speciality (MD) in India. They developed a portfolio approach identifying 114 EPAs and 961 milestones linked to the Indian National Medical Commission (NMC) curriculum guidelines. Initial steps were EPA developments within the faculty, benchmarking the EPAs against the national guidelines, deconstructing these EPAs and milestones using a portfolio, portfolio design followed by final portfolio discussion. Since this portfolio of EPAs was only recently developed and has not been implemented yet, it remains to be seen how effective it is a pedagogic tool.

An exploratory paper by Smith (2019) was the first to apply entrustable professional activities to Sport and Exercise Sciences, specifically at masters level (FHEQ Level 7). This is an important distinction as the BASES accreditation is currently solely for postgraduate level practitioners and applicants are required to have an undergraduate qualification as part of the accreditation process. In addition, at this level, students will be expected to have developed an appropriate skill and competency base that can be considered ready to be assessed for entrustment and responsibility in a professional setting such as working with clients or athletes/players. The paper describes a process for identifying and defining EPA within Sport and Exercise Sciences, providing three frameworks that provide a stepwise pathway to the creation of a curriculum to incorporates EPAs. A key point that Smith highlights is the need to align the EPA with available national frameworks to ensure they encompass industry or professional standards. This ensures that the activities are linked to work-based actions (Meyer et al., 2019) and aid development towards expertise in practice (ten Cate, 2013). As the initial primer paper on EPA by ten Cate (2005) outlines the principles of the paradigm employed in the research, this paper provides excellent guidance for implementing EPAs within Sport and Exercise Sciences by considering specific issues relevant to the academic field that may not be considered in the usual application across medical education.

1. **Framework Development**
   1. ***EPA Framework and Implementation***

To develop an EPA framework for undergraduate Sport and Exercise Sciences, a two-step process was employed. Firstly, the structure of an introductory (Level 4) Sport and Exercise Sciences module was considered. This was a single semester module that was taught through a 1-hour lecture, a 2-hour practical followed by a 1-hour seminar to discuss or analyse the practical. The module was structured to introduce the three key disciplines of physiology, psychology, and biomechanics by demonstration and practice of test protocols. Additional sessions on generic topics including validity and reliability, normative data, and understanding your client were also scheduled on the module. This module was complemented by separate discipline specific modules. Students were required to create a portfolio of evidence through description and discussion of each test completed during the weekly classes. Assessment used a case-study approach involving a summary report explaining the Sport and Exercise Science support process for one of a selection of athletes or sports teams. This enabled personalisation of the work to the students’ area of interest, followed by a second assessment which was a group presentation of the support process.

Subsequently, an EPA framework for use in Sport and Exercise Sciences was developed. A list of desired attributes for a sport and exercise scientist were defined by the lead author, an experienced BASES accredited sport and exercise scientist and then assigned to entrustable professional activity domains, which were checked for consistency by a second member of the research team These domains were ‘Effective Implementation’, ‘Evaluation of Practice’, and ‘Student Behaviours’ (See Table 1.). The BASES Accreditation competency profile was downloaded from the BASES website (https://www.bases.org.uk/imgs/accreditation\_competency\_profile\_feb\_18504.pdf) and reviewed to identify key words that describe actions required to demonstrate competence. From the 10 competency categories in the BASES profile, 20 common actions were identified, of which 11 were selected for inclusion in the EPA framework (Table 2). Not all BASES competency actions were included as the accreditation is designed for postgraduate level (FHEQ Level 7) and it would not be possible for students studying at undergraduate level to achieve them. An EPA matrix was then created that ensured that all the BASES competency areas were comprehensively covered by the EPAs selected. The lowest coverage was the area of ‘Application of Knowledge and Skills’ that was only included in two actions, with all other BASES competency areas including three to five actions. To enable assessment of students’ ability to perform the EPA during the introductory module, a competency assessment recording sheet was created that allowed the identification of the level of supervision on a four-step scale, where step one assumes no task execution, step two demonstrates task execution under direct supervision, step three allows replication and practice to achieve task execution with minimal supervision, and step four allows unsupervised task execution. Both the EPA matrix and recording sheet were reviewed by another experienced sport and exercise scientist to check the coverage of the actions and the appropriateness of the documents for use within the introductory module.

Table 1: Defining the desired Sport and Exercise Scientist attributes and Entrustable Professional Activity domain.

|  |  |
| --- | --- |
| Attribute | EPA Domain |
| Knowledge, Skill, Safety, Practice, Technical Ability, Client Handling, Activity Planning | Effective Test Implementation |
| Analysis, Feedback, Understanding, Reflection, Comparison, Referencing, Data Management | Evaluation of Practice |
| Independence, Professionalism, Autonomy, Development, Care | Student Behaviours |

Table 2: BASES competency actions and EPA domain selection

|  |  |
| --- | --- |
| Action Statements | EPA Domain |
| Communication | Effective Test Implementation |
| Implementation | Effective Test Implementation |
| Select and Record | Effective Test Implementation |
| Set Goals | Effective Test Implementation |
| Maintain Health and Safety | Effective Test Implementation |
| Analyse and Handle Data | Evaluation of Practice |
| Validity/Reliability | Evaluation of Practice |
| Research | Evaluation of Practice |
| Engagement with Client | Evaluation of Practice |
| Diversity and Duty of Care | Student Behaviours |
| Independence | Student Behaviours |
| Judgement | Student Behaviours |
| Interpret | (Not included due to levelness) |
| Adapt | (Not included due to levelness) |
| Monitor | (Not included due to levelness) |
| Quality Control and Assurance | (Not included due to levelness) |
| Delivery | (Not included due to levelness) |
| Use of Technology | (Not included due to levelness) |
| Diagnose | (Not included due to levelness) |

* 1. ***Framework Evaluation***

The EPA framework was evaluated by asking students to rank the importance of the competency action statements where 1 indicated the most important statement and 12 indicating the least important to identify students’ perception of the importance of these attributes to inform future development of the framework. Students were invited to complete a paper copy of a questionnaire ranking the statements in week 13 of the module schedule and returned to a box outside the classroom. A follow-up reminder message was sent one week later to improve the response rate through the University VLE system (Canvas).

Ethical approval was obtained from the University Institutional Research Ethics Group (Ref No. 005850). This was required as the participants were providing information beyond what was normally required for the module, and due to the student-teacher relationship, were providing information on what may be construed as questioning the module leader’s teaching style and ability and students may not be comfortable in doing this. To minimise the risk of response bias this may have created and to ensure that students did feel coerced in to responding, the students were informed that their decision would not impact on their mark for the assessment or module in any way and all had the right to refuse to participate or withdraw at any stage without any consequence. Written informed consent was obtained from all students who agreed to participate. All students in the class (n = 45) were invited to participate with a total 29 students completed the ranking questionnaire (64% response rate).

* 1. ***Data Analysis***

Mean (± SD) ranking of each EPA action statement was calculated to indicate the importance of the competencies to the students. To identify if a particular action statement was more important than any other, Friedman Tests were conducted through analysis of paired mean rankings. Significance was set at ρ < 0.05 *a priori*. Similar to the questionnaire responses, a cluster analysis was conducted to identify common EPA action statements. All statistical analysis was conducted using SPSS v24 (IBM SPSS Statistics, IBM Co., Armonk, NY).

1. **Results**
   1. **Framework Assessment**

The rank importance of each of the EPA action statements on the competency matrix is given in Table 3. ‘Maintaining health and safety’ was deemed the most important EPA action statement out of the twelve with a mean rank of 3.5 ± 2.8, followed by ‘Duty of care’ and ‘Communication of procedure’. ‘Autonomy of practice’ was ranked the least important action statement with a mean rank of 7.7 ± 3.2. The outcome of the Friedman Tests indicated significant differences existed between the ranks of the action statements (F = 33.27; ρ = 0.0005). Further analysis using the Wilcoxon Signed Rank Test identified that Maintaining Health & Safety ranked significantly more important than the following: Analysis & Interpretation (z = 2.43; ρ = 0.015), Selection of Equipment/Technology (z = 2.95; ρ = 0.003), Ability to Research Appropriate Practice (z = 2.89; ρ = 0.004), Goal Setting and Planning (z = 2.93; ρ = 0.003), Measurement and Data Handling (z = 2.72; ρ = 0.007), Implementation of Validity and Reliability (z = 3.22; ρ = 0.001), Maintain Inclusion and Diversity (z = 3.36; ρ = 0.001), and Autonomy of Practice (z = 3.27; ρ = 0.001). Additionally, Duty of Care ranked significantly more important than Implementation of Validity and Reliability (z = 2.12; ρ = 0.034), Maintain Inclusion and Diversity (z = 2.94; ρ = 0.003), and Autonomy of Practice (z = 2.41; ρ = 0.016) and Communication of Procedure ranked significantly more important than Autonomy of Practice (z = 2.23; ρ = 0.026).

A cluster analysis was conducted on the EPA action statements to identify if specific statements were linked or shared commonalities. Table 4 indicates the membership of each statement to one of four distinct groups. This is graphically represented in Figure 1. The dendrogram displays the four clusters based on the distinct linkages, the first separation (from the right-hand side is seen at the first level, creating a cluster (1) comprising ‘Communication of Procedure’, ‘Maintain health and safety’, and ‘Duty of care towards athlete/client’. The second separation occurs at the second level, creating a cluster (2) comprising ‘Analysis and interpretation’, and ‘Engagement with athlete/client’. The third separation occurs at the third level, creating the final two clusters: A cluster (3) comprising ‘Ability to research appropriate practice’, ‘Autonomy of practice’, and ‘Maintain inclusion and diversity’; and a cluster (4) comprising ‘Goal setting and planning’, ‘Selection of equipment/technology’, ‘Measurement and Data Handling’, and ‘Implementation of validity and reliability’. The statements in cluster 1 generally relate to an EPA area involving safety, while the statements in cluster 2 generally relate to an EPA area involving Feedback/Feedforward. Cluster 3 generally relate to an EPA area around professional attributes, while cluster 4 generally relate to practical tasks within sport science support and an EPA area of testing.

Table 3. Rank importance of EPA statements on the competency matrix

|  |  |
| --- | --- |
| Statement | Mean Rank Importance |
| Maintain health and safety | 3.5 ± 2.8 |
| Duty of care towards athlete/client | 4.8 ± 4.0 |
| Communication of procedure | 5.2 ± 3.3 |
| Engagement with athlete/client | 5.9 ± 3.4 |
| Analysis and interpretation | 6.6 ± 3.6\* |
| Selection of equipment/technology | 6.7 ± 2.6\* |
| Ability to research appropriate practice | 6.7 ± 3.0\* |
| Goal setting and planning | 6.8 ± 3.1\* |
| Measurement and data handling | 6.8 ± 3.6\* |
| Implementation of validity and reliability | 7.1 ± 3.5\*# |
| Maintain inclusion and diversity | 7.5 ± 3.5\*# |
| Autonomy of practice | 7.7 ± 3.2\*#‡ |

Rank: 1: Most Important; 12: Least Important; \* Significantly different (ρ < 0.05) than Maintain Health and Safety; # Significantly different (ρ < 0.05) than Duty of Care; ‡ Significantly different (ρ < 0.05) than Communication.

Table 4. Cluster membership of the EPA action statements

|  |  |
| --- | --- |
| Question | Cluster |
| Communication of procedure | 1 |
| Duty of care towards athlete/client | 1 |
| Maintain health and safety | 1 |
| Analysis and interpretation | 2 |
| Engagement with athlete/client | 2 |
| Ability to research appropriate practice | 3 |
| Autonomy of practice | 3 |
| Maintain inclusion and diversity | 3 |
| Goal setting and planning | 4 |
| Selection of equipment/technology | 4 |
| Measurement and Data Handling | 4 |
| Implementation of validity and reliability | 4 |

Chart, diagram

Description automatically generated

Figure 1. Cluster membership of Entrustable Professional Activities action statements.

1. **Discussion**

The aim of the paper was to describe the implementation of entrustable professional activities into the curriculum for Sport and Exercise Sciences undergraduate teaching in higher education. To facilitate this, practical competencies were described within an EPA framework linked to national body accreditation protocol. Additionally, the framework was assessed for learner worth through the ranking of competency importance by a group of undergraduate Sport and Exercise Sciences students.

An EPA framework was created based on the BASES Accreditation competency profile and implemented into an undergraduate Sport and Exercise Sciences module. EPAs are a modern and updated version of competency-based medical education that utilise specific tasks as a pedagogic approach to develop student abilities. EPAs can be termed units of professional practice and links competencies to work-based actions in an integrated process. In the current paper the framework was defined as a competency matrix, with competency statements linked to one of three desired attributes, as EPAs were not related to specific tasks and were designed to cover all of the different tests included in the module. Therefore, the EPA framework described attributes the students should display, rather than specific Sport and Exercise Science activities the student should perform to show competence. Key tests and protocols need to be identified that a Sport Scientist would be expected to perform. For example, this may include “perform a maximal aerobic assessment”, “perform a vertical jump assessment”, “accurately take skinfold body fat measures”, or “conduct a patient centred, holistic, pre-exercise health assessment” and are dependent on the specific discipline within Sport and Exercise Sciences. This is a common approach to developing useful EPAs, as seen in intensive care medicine training in the Netherlands (van Bockel et al., 2019) and is the starting point of the EPA framework set out by Smith (2019). To further develop an EPA framework to overcome this issue, it would be beneficial to form expert groups from within each discipline to create a list of these key activities and then assess the quality and appropriateness of each EPA. The use of Delphi method, which is iterative process to achieve consensus from experts could be implemented to achieve this (Wagner and Reeves, 2015). However, one of the primary barriers to this framework development is that the description of the criteria for the BASES Accreditation is flexible and this allows interpretation by practitioners and institutions as to what can and should be included as evidence and allows specialisation. It may be appropriate for the national body to define their criteria more specifically as a way to promote or facilitate the creation of suitable EPAs for use within Sport and Exercise Sciences. This was performed by the Association of American Medical Colleges (Obeso et al., 2017), the Accreditation Council for Graduate Medical Education in the USA (Krupat, 2018), or the Association for Medical Education in Europe (ten Cate et al., 2015). Additionally, the General Medical Council in the UK provide guidance to the set of practical skills and procedures that newly qualified doctors must have on commencement of work. https://www.gmc-uk.org/education/standards-guidance-and-curricula/standards-and-outcomes/outcomes-for-graduates/outcomes-for-graduates---practical-skills-and-procedures) Importantly this guidance relates to a minimum level of performance based on three levels of competence and the ability to practice under decreasing levels of supervision, similar to the core tenant of EPAs. These national associations provide clear guidance and accepted clinical activities that graduate medical students should be able to perform without supervision and provide the basis for the EPA in medical sub-disciplines.

Initial construction of the EPA framework aligned statements to one of three areas within the competency matrix (‘Effective Implementation’; ‘Evaluation of Practice’; ‘Student Behaviours’). These were similar to the two EPAs defined by Smith (2019) of ‘Ensuring Athlete Safety and Welfare’ and ‘Undertaking the Assessment Effectively.’ In the current project, ‘Student Behaviours’ were created as a separate EPA to improve clarity of this area to the students and highlight their importance of themselves and their personal and professional attributes as specific required competencies. However, the individual elements of ‘Student Behaviours’ are reflected in the ‘Ensuring Athlete Safety and Welfare’ EPA developed by Smith (2019), which includes components such as ‘Respecting athlete dignity’. One of the drivers for the EPA selection and definition by Smith (2019) was alignment to the BASES Accreditation competencies, as they state the requirement to reference industry standards and regulatory frameworks (Hauer et al., 2013) strengthens the applicability of EPA. Similarly, in the current project, each matrix statement was mapped against the BASES Accreditation competencies to ensure full and adequate coverage (each statement aligned to at least three BASES competencies), and the statements were then assigned to one of the three EPAs.

The importance of the EPA statements in the competency matrix reported by the students indicated that ‘maintaining health and safety’ was the most important followed by ‘duty of care’ and ‘communication of procedure’ and these were generally rated as significantly more important than the other statements. All three of these are key competencies, as ensuring client welfare is the most important skill for a sport and exercise scientist when providing support and testing. The outline for BASES Accreditation states that it is a professional standard to practitioners deemed necessary to practice safely and effectively. This mirrors the medical and allied health professional fields, where ensuring that a patient is treated well and not subjected to any unnecessary treatment that may unduly affect them is a prime directive. The fact that students reported that these were the most important is very promising in the development of the framework. This was designed to specifically develop an understanding of the operational tasks required when providing sport and exercise science support and students were able to identify that health and safety and duty of care are important attributes within the role. This implies that the structure and pedagogic approach to teaching and learning in Sport and Exercise Sciences when aligned to an EPA framework can adequately prepare students to recognise the attributes required to act in an appropriate manner. Additionally, the competencies of maintaining health and safety, duty of care, and communication of procedure are generic and can be assessed as key competencies on other modules across the programme.

Interestingly, one of the main principles and outcomes of EPAs was deemed by students to be least important of those included. A primary aim of the use of EPAs is to be able to accurately and reliably assess when supervision can be reduced to the point where a student can act independently or work autonomously (Weller et al., 2014). Of all the competency statements within the matrix, Autonomy of Practice was ranked the lowest (mean rank 7.7 ± 3.2 out of 12). This is most likely a reflection of the difficulty in teaching such a personal attribute that the student must develop through ongoing exposure to practical based activities and increased experience that is likely to create confidence. It may also reflect students’ awareness of their stage of learning and the expectations they and others may have of their ability to work independently at Level 4. This is a graduate level attribute (Level 6) and the BASES Accreditation is devised to be at Level 7 in which the competency of ‘Work autonomously and take responsibility for the work of self and others’ is seated. Where students are at the beginning of their undergraduate journey, and at the earlier stages of learning (Dreyfus & Dreyfus, 1980), it is more likely that they are more focused on developing generic learning skills and discipline specific knowledge (Stage 2: Advanced Beginner or Stage 3: Competency) and this will progress to application that will develop throughout the undergraduate degree and through future opportunities (Stage 4: Proficiency) (Dreyfus, 2004). Indeed, the practical skills, such as ‘Analysis and Interpretation’ and ‘Selection of Equipment’ were ranked 4th and 5th overall. It is probable that development of the EPA framework should result with this statement introduced at a later time point in the undergraduate programme, for example at Level 6, by which time of study they should have developed the threshold knowledge and skills (Mossley, 2017) and be in a position to apply them in a professional practical setting.

Examination of the EPA statements through cluster analysis indicated that the statements formed four clusters based on commonalities based on the importance assigned by the students. The first cluster are focused on client safety, while the third cluster relate to professional attributes and these roughly align with the first EPA defined by Smith (2019) ‘Ensuring Athlete Safety and Welfare’. Then cluster 2 involved providing information to the client and cluster 4 relate to the practical tasks within sport science support and these two roughly align to the second EPA defined by Smith (2019) ‘Undertaking the Assessment Effectively’. Comparison of the structure of the current EPAs with the work of Smith within Sport and Exercise Sciences and the BASES Accreditation Scheme indicates that the competency matrix is an appropriate and useful tool to facilitate student learning. However, work is needed in light of the identification of differences between the original EPA statements of Smith (2019) and further mapping should be undertaken to improve the effectiveness of the document to benefit the students going forwards. A potential solution to this could be the creation of industry-defined core EPA for different Sport and Exercise Sciences disciplines (Physiology, Psychology, Biomechanics, Performance Analysis) based upon the BASES accreditation.

As students are the end users of undergraduate learning and teaching, changes to educational methods directly impact them. Therefore, understanding student perceptions, thoughts, and feelings towards curricula can assist higher education institutions in developing robust and appropriate delivery. Previous studies have investigated student perceptions of EPAs to identify and understand how they affect learning (Duijn, Welink, Mandoki, ten Cate, Kremer, and Bok, 2017; Rhodes, Weck Marciniak, McLaughlin, Melendez, Leadon, & Pinelli, 2017; Pittenger, Gleason, Haines, Neely, & Medina, 2019; Lau, Ang, Samarasekera, & Shorey, 2020) with generally positive outcomes including relevance (Pittenger et al., 2019), facilitation of critical thinking (Lau et al., 2020), and aid progression to non-supervision of practical skills (Duijn et al., 2017). This study follows a similar approach in engaging students in the research process to evaluate the EPA statements and this may provide useful guidance to educators and facilitate the production of student focused learning environments.

***Issues and Limitations***

The paper is based on the integration of entrustable professional activities into Sport and Exercise Sciences undergraduate study and is designed to present the case for the use of EPA. No evaluation of the implementation of EPA into the curriculum is presented and future studies should endeavour to understand if EPA improve student success. Furthermore, the EPA in this study was implemented into programme at a single higher education institution with a specific class size and this will limit the generalisability of the findings. Future studies should focus on widening the scope of EPAs in sport and exercise sciences to ascertain if they are applicable across the discipline. Ten Cate (2018) described EPAs as a unit of professional practice, while Chen and colleagues (2015) state that EPAs must incorporate abilities and apply them as integrated skills. More so, EPA links competencies to work-based actions (Meyer et al., 2019) and they are not just competencies in themselves. An EPA should be related to a clearly defined task that when performed, allow specific competencies to be displayed (Smith, 2019). It is probable that the EPAs in the current study do not provide enough clarity to make them wholly effective as students were unsure of their exact meaning or how an actual EPA differed from a competency. Additionally, the levelness of competencies and EPAs require consideration to ensure that they are appropriate to develop student learning. A review of the EPA framework should be undertaken after each year for at least the first few iterations of a module to address any issues in its implementation. This would form good pedagogic practice as a more refined understanding of the meaning of the EPAs and an integration of new thoughts on what defines EPAs would allow the project to develop. In creating module descriptors, flexibility in terms of the description of the module content, delivery and assessment would enable minor alterations to be made without requiring frequent module changes to go through quality assurance processes unnecessarily. In addition, Level 4 students may fail to understand the concepts such as autonomy, validity and reliability, inclusion and diversity which may limit their ability to rate these attributes. Clear articulations of the EPA statements is required to ensure student understanding of these factors.

* 1. **Conclusion**

Entrustable professional activities are a modern and updated version of competency-based medical education that utilise specific tasks as a pedagogic approach to develop student abilities. EPAs can be termed units of professional practice and EPAs link competencies to work-based actions in an integrated process. EPAs and competencies provide clear alignment of learning activities and practical skill development in discipline of Sport and Exercise Sciences towards students’ professional development of attributes and skills. This is very important in developing work-ready sport and exercise scientist on graduation and ensuring they are aware of the requirements of the role at the start of their development. Students identified that the most important competencies were maintaining health and safety, duty of care, and communication of procedure with the least important being autonomy of practice. The three most important competencies focus on ensuring you look after your client and the pedagogic approach to teaching and learning is achieving a desired outcome and are preparing the students to act in an appropriate manner. Additionally, these are generic competencies that can be applied at all levels on an undergraduate Sport and Exercise Sciences programme.

**Declaration of Interests:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

1. **References**
2. Block, J. H. (1974). *Schools, society, and mastery learning*. Holt, Rinehart and Winston.
3. Carraccio, C., Wolfsthal, S. D., Englander, R., Ferentz, K., & Martin, C. (2002). Shifting paradigms: From Flexner to competencies. *Academic Practice*, *77*(5), 361-367.
4. Caverzagie, K. J., Iobst, W. F., Aagaard, E. M., Hood, S., Chick, D. A., Kane, G.C., Brigham, T. P., Swing, S. R., Meade, L. B., Bazari, H., Bush, R. W., Kirk, L. M., Green, M. L., Hinchley, K. T., & Smith, C. D. (2013). The internal medicine reporting milestones and the next accreditation system. *Annals of Internal Medicine*, *158*, 557–559.
5. Chen, H. C., van den Broek, W. E. S., & ten Cate, O. (2015). The case for the use of entrustable professional activities in undergraduate medical education. *Academic Medicine*, *90*(4), 431-436.
6. Collins, D., Burke, V., Martindale, A., & Cruickshank, A. (2015). The illusion of competency versus the desirability of expertise: Seeking a common standard for support professions in sport. *Sports Medicine*, *45*, 1-7.
7. Crossley, J., & Jolly, B. (2012). Making sense of work-based assessment: Ask the right questions, in the right way, about the right things, of the right people. *Medical Educator*, *46*,28-37.
8. Dath, D., & Iobst, W. (2010). The importance of faculty development in the transition to competency-based medical education. *Medical Teacher*, *32*(8), 683-686.
9. Datta, K., Guru, C. C., Krishnan, A., Datta, R., & Sharma, D. (2021). Entrustable professional activities (EPAs) and milestones for MD sports medicine: A proposed portfolio. *Medical Journal Armed Forces India*, *77*(1), S129-S133.
10. Dawson, M., Cook, F., & Lambton, A. (2014). Active Engagement Strategies: Students as Co-creators of Knowledge. In: EDULEARN14: 6th International Conference on Education and New Learning Technologies, 7-9 Jul 2014, Barcelona, Spain
11. Demers, G., Woodburn, A. J., & Savard, C. (2006). The development of an undergraduate competency-based coach education program. *The Sport Psychologist*, *20*, 162-173.
12. Derbyshire, P., & McDonald, H. (2004). Choosing response scale labels and length: Guidance for researchers and clients. *Australian Journal of Market Research*, *12*,17-26.
13. Dewey, C. M., Jonker, G., ten Cate, O., & Turner, T. L. (2017). Entrustable professional activities (EPAs) for teachers in medical education: Has the time come? *Medical Teacher*, *39*(8), 894-896.
14. Dreyfus, H. L., & Dreyfus, S. E. (1980). *A five-stage model of the mental activities involved in directed skill acquisition*. Storming Media.
15. Dreyfus, S. E. (2004). The five-stage model of adult skill acquisition. *Bulletin of Science, Technology & Society*, *24*(3), 177-181.
16. Duijn, C.C.M.A., Welink, L.S., Mandoki, M., ten Cate, O., Kremer, W.D.J., & Bok, H.G.J. (2017). Am I ready for it? Students’ perceptions of meaningful feedback on entrustable professional activities. *Perspectives on Medical Education*, 6(4), 256-264.
17. Epstein, R. M., & Hundert, E. M. (2002). Defining and assessing professional competence. *JAMA: The Journal of the American Medical Association*, *287*(2), 226-235.
18. Ericsson, K. A., Krampe, R. Th., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, *100*(3), 363-406.
19. Fletcher, D., & Maher, J. (2013). Toward a competency-based understanding of the training and development of applied sport psychologists. *Sport, Exercise, and Performance Psychology*, *2*(4), 265-280.
20. Gros, B., & Lopez, M. (2016). Students as co-creators of technology-rich learning activities in higher education. *International Journal of Educational Technology in Higher Education*, *13*, 1-13.
21. Gruppen, L. D., Burkhardt, J. C., Fitzgerald, J. T., Funnell, M., Haftel, H. M., Lypson, M. L., & Vasquez, J. A. (2016). Competency-based education: programme design and challenges to implementation. *Medical Education*, *50*, 532-539.
22. Guilbert, J-J. (2002). The ambiguous and bewitching power of knowledge, skills and attitudes leads to confusing statements of learning objectives. *Education for Health*, *15*(3), 362-369.
23. Harden, R. M. (2002). Learning outcomes and instructional objectives: is there a difference? *Medical Teacher*, *24*(2), 151-155.
24. Harris, P., Snell, L., Talbot., & Harden, R. M. (2010). Competency-based medical education: implications for undergraduate programs. *Medical Teacher*, *32*(8), 646-650.
25. Hauer, K. E., Kohlwes, J., Cornett, P., Hollander, H., ten Cate, O., Ranji, S. R., Soni, K., Iobst, W., & O’Sullivan, P. (2013). Identifying entrustable professional activities in internal medicine training. *Journal of Graduate Medical Education*, *5*(1), 54-59.
26. Iobst, W. F., Sherbino, J., ten Cate, O., Richardson, D. L., Dath, D., Swing, S. R., Harris, P., Mungaroo, R., Holmboe, E. S., & Frank, J. R. (2010). Competency-based medical education in postgraduate medical education. *Medical Teacher*, *32*, 651-656.
27. Krupat, E. (2018). Critical thoughts about the core entrustable professional activities in undergraduate medical education. *Academic Medicine*, *93*(3), 371–6.
28. Kwan, J., Crampton, R., Mogensen, L. L., Weaver, R., van der Vleuten, C. P. M., & Hu, W. C. Y. (2016). Bridging the gap: a five stage approach for developing speciality-specific entrustable professional activities. *BMC Medical Education*, *16*, 117.
29. Lau, S.T., Ang, E., Samarasekera, D.D., & Shorey, S. (2020). Evaluation of an undergraduate nursing entrustable professional activities framework: An exploratory qualitative research. *Nurse Education Today*, 87, 104343, DOI: 10.1016/j.nedt.2020.104343.
30. Le Meur, Y., & Torres-Ronda, L. (2019). 10 challenges facing today’s applied sports scientist. *Sports Performance and Science Reports*, *57*, 1-7.
31. Loftus, S. (2016). Competencies in medical education: a trap for the unwary. *Medical Science Educator*, *26*, 499-502.
32. Meyer, E. G., Chen, H. C., Uijtdehaage, S., Durning, S. J., & Maggio, L. A. (2019). Scoping Review of Entrustable Professional Activities in Undergraduate Medical Education. *Academic Medicine*, *94*(7), 1040-1049.
33. Mossley, D. 2017. *Reflecting on threshold concepts: an introductory tool*. Higher Education Academy.
34. Obeso, V., Brown, D., Aiyer, M., Barron, B., Bull, J., Carter, T., Emery, M., Gillespie, C., Hormann, M., Hyderi, A., Lupi, C., Schwarz, M., Uthman, M., Vasilevskis, E. E., Yinling, S., & Phillipi, C. (Eds.). (2017). *Core EPAs for Entering Residency Pilot Program. Toolkits for the 13 Core Entrustable Professional Activities for Entering Residency.* Association of American Medical Colleges; aamc.org/initiatives/coreepas/publicationsandpresentations.
35. O’Dowd, E., Lydon, S., O’Connor, P., Madden, C., & Byrne, D. (2019). A systematic review of 7 years of research on entrustable professional activities in graduate medical education, 2011-2018. *Medical Education*, *53*(3), 234-249.
36. Pangaro, L., & ten Cate, O. (2013). Frameworks for learner assessment in medicine: AMEE guide no. 78. *Medical Teacher*, *35*, e1197-e1210.
37. Pittenger, A.L., Gleason, B.L., Haines, S.T., Neely, S., & Medina, M.S. (2019). Pharmacy students perceptions of the entrustable professional activities. *American Journal of Pharmaceutical Education*, 83(9), 1974-1982.
38. Rhodes, L., Weck Marciniak, M., McLaughlin, J., Melendez, C., Leadon, K., & Pinelli, N. Exploratory analysis of entrustable professional activities as a performance measure during early practice experiences in a doctor of pharmacy program. *American Journal of Pharmaceutical Education*, 83(2), 6571.
39. Sleep, M., & Reed, H. (2006). Views of sport science graduates regarding work skills developed at university. *Teaching in Higher Education*, *11*(1), 47-61.
40. Smith, M.D. (2019). The application of entrustable professional activities (EPAs) within sport science education: An exploratory approach. *The University of Lincoln Journal of Higher Education* Research, *1*(5), DOI: 10.25507/15201938
41. Talbot, M. (2004). Monkey see, monkey do: A critique of the competency model of graduate medical education. *Medical Education*, *38*(6), 587-592.
42. Ten Cate, O. 2005. Entrustability of professional activities and competency‐based training. *Medical Education*, *39*(12), 1176-1177.
43. Ten Cate, O. (2013). Nuts and bolts of entrustable professional activities. *Journal of Graduate Medical Education*, *5*, 157-158.
44. Ten Cate, O., Chen, H. C., Hoff, R. G., Peters, H., Bok, H., & van der Schaaf, M. (2015). Curriculum development for the workplace using Entrustable Professional Activities (EPAs): AMEE Guide No. 99. *Medical Teacher*, *37*(11), 983-1002.
45. Ten Cate. (2018). A primer on entrustable professional activities. *Korean Journal of Medical Education*, *30*(1), 1-10.
46. Ten Cate, O., & Scheele, F. (2007). Viewpoint: competency-based postgraduate training: can we bridge the gap between theory and clinical practice? *Academic Medicine*, *82*(6), 542-547.
47. Van Bockel, E. A. P., Walstock, P. A., van Mook, W. N. K. A., Arbous, M. S., Tepaske, R., van Hemmel, T. J. D., Muller, M. C. A., Delwig, H., & Tulleken, J. E. (2019). Entrustable professional activities (EPAs) for postgraduate competency based intensive care medicine training in the Netherlands: The next step towards excellence in intensive care medicine training. *Journal of Critical Care*, *54*, 261-267.
48. Van Loon, K. A., Driessen, E. W., Teunissen, P. W., & Scheele, F. (2014). Experiences with EPAs, potential benefits and pitfalls. *Medical Teacher*, *36*(8), 698-702.
49. Wagner, S. J., & Reeves, S. (2015). Milestones and entrustable professional activities: the key to practically translating competencies for interpersonal education? *Journal of Interprofessional Care*, *29*(5), 507-508.
50. Weller, J. M., Misur, M., Nicolson, S., Morris, J., Ure, S., Crossley, J., & Jolly, B. (2014). Can I leave the theatre? A key to more reliable workplace-based assessment. *British Journal of Anaesthesia*, 112(6), 1083-1091.