1. From outsider to insider: the effect of engaging in action research on developing and assessing critical writing and subject knowledge in a second-year microbiology module.

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Introduction

> *The real voyage of discovery consists not in seeking new landscapes but in having new eyes.* Marcel Proust (1871 - 1922).

I came to teaching at the Department of Science and Health in the Institute of Technology Carlow (IT Carlow) from a microbiology research background and had practical experience with the concepts of knowledge construction, robust self and peer assessment and autonomous learning; features common to all levels of education. I became increasingly interested in the pedagogy of both undergraduate and postgraduate education and availed of a number of both accredited and non-accredited professional development opportunities. These I feel have improved my teaching practice, allowed me to engage with a network of supportive teaching professionals and introduced me to the underpinning pedagogical theories of higher education (Biggs & Tang, 2011; Ramsden, 2003) and the concept of the scholarship of teaching (Boyer, 1990).

In 2012, I registered for a MA in Teaching and Learning (MATL) at IT Carlow and had further opportunities to reflect on my practice, identify my core values as an educator and recognise the significance of social purpose and participatory action research in improving my practice (Coghlan, 2011; Coghlan & Coughlan, 2012; McNiff, 2014; McNiff & Whitehead, 2011). Throughout the MATL programme I examined my teaching in the light of the literature and discussions with peers, reflected and made changes accordingly. I identified two areas of special relevance to me: the tension between research and teaching especially in the Institutes of Technology and the importance of assessment and feedback in an aligned curriculum.

For my dissertation, (Brazil, 2014), I used an action research approach to address my concern of how best to support second year (level 6) Bioscience students to develop enquiry-based learning skills to facilitate enduring independent learning in a microbiology module. To facilitate this I adapted the flexible, cyclical and reiterative Research Skills Development Framework (RSD), developed by Willison and O'Regan (2007). The process of engaging with the MATL programme and of taking an action research approach, despite my initial resistance, has been personally transformative and has enabled me to be more reflective and continue to learn about and improve my practice. My personal transformation has had a positive impact on the students involved. Participants in the interventions involved, showed a willingness to embrace the new research-orientated learning activities; engaged in self- assessment and feedback, shared their views on research and enquiry, and also demonstrated autonomously researched knowledge in the terminal examination.

This chapter explores my personal transformation as I tried to develop research skills in a microbiology module among 2nd year Bioscience students and the impact this change had on the students participating in the intervention.

Core value: The importance of undergraduate research and enquiry

My own experience and the literature (Biggs & Tang, 2011; Healey & Jenkins, 2009; 2014) has convinced me, that research, meaning the construction of new knowledge, is the basis of deep and enduring learning for all learners. I conclude that my experience of the research process has helped me better understand theories of learning. Baxter Magolda's (1992) view of the different levels through which a learner passes, from certain knowledge through to the contextual nature of knowledge, resonates with my research experience.

The equally important strands of undergraduate research and teaching in the curriculum are an essential feature of modern third level education (Healey & Jenkins, 2009; Institute of Technology Carlow, 2014; NAIRTL, 2010). However, my impression is that 'research' is often seen to be in competition with teaching especially in Institutes of Technology (IoTs), whose mission is seen to be more applied than that of research intensive universities (McGuinness, 2013, pp. 17-19). However many commentators strongly argue that research skills are equally important in less research intensive institutions (Healey & Jenkins, 2014; Jenkins & Healey, 2011; Spronken-Smith, 2010). I prefer to use the more inclusive term undergraduate "research and enquiry" to describe a valuable process that all learners, not only high achievers destined for academic careers, can engage in.

My concern: Are there opportunities to engage with research and enquiry?

I had struggled with how best to develop research and enquiry skills among my own undergraduate students, at levels 6, 7 and 8 of the National Framework of Qualification (2009). In the Department of Health and Science, in keeping with Institute policies (Institute of Technology Carlow, 2014; 2015a; 2015b) all students are expected to explicitly engage in independent learning and enquiry and complete independent literature and practical-based research projects at level 7 and level 8. However, from my own observations, speaking with other colleagues and external examiners, students, even at levels 7 or 8, often fail to demonstrate the deeper approaches to learning of a topic expected from engaging in independent enquiry. Students often also fail to show the expected research-oriented skills, such as recognising credible sources, critical reading and academic writing.

I felt that if students could engage with a structured research activity involving critical reading processes and supported academic writing early in the academic programme these skills would improve and deeper and enduring learning of content and concepts might occur. To this end I tried to address some of the critical reading issues with second year Bioscience students as part of a microbiology module by giving short written independent research assignments on specific topics. While most students completed the assignments satisfactorily, difficulties with paraphrasing, citations and referencing were evident. I noticed that, American exchange students had better academic writing skills than their IT Carlow classmates, which was due in part to them having been explicitly taught how to write prior to the exchange. I realised that I had been expecting students to engage in research and academic writing yet had been failing to provide appropriate support for the independent construction of enduring learning. The challenge was to find a way to explicitly develop relevant research and enquiry skills such as critical reading from credible sources and academic writing skills within the context of the existing microbiology module that would help develop independent learning.

Research skills development framework

There are many models that develop and embed undergraduate research and enquiry skills within the curriculum (Bradley, 2007; Hanratty, Higgs & Tan, 2011; Healey & Jenkins, 2009; 2014; NAIRTL, 2010; Spronken-Smith, 2010). One model is the Research Skills Development (RSD) framework developed by Willison and O'Regan (2007) in the University of Adelaide. I was drawn to the RSD as it is very adaptable and can be applied to different learning activities, disciplines and educational levels including the Irish higher educational context (Willison, 2010).

Following evaluation, the RSD framework has been found to be useful at improving research skills across a range of disciplines and academic levels (Willison, 2012; Willison, Le Lievre & Lee, 2010).

The RSD framework provides a conceptional and practical means to develop both subject knowledge and research and enquiry skills. All enquiry/research activities, from primary school to PhD. are considered to be on the same continuum that ranges from supported closed structured enquiry, level 1, to cutting edge, level 5 (see http://www.adelaide.edu.au/rsd/). What matters is the amount of support given to the learner. This concept resonates with my own view, supported by others, (Baxter Magolda, 1992; Hodge, Haynes, Lepore, Pasquesi & Hirsh, 2008), that all learners construct, via research, their own knowledge to some extent, moving from the unknown to the known.

In the RSD framework, learning activities, from single assignments to programmes, can be reframed into six facets or indicators of learning which correspond to six key research skills (Willison & O' Regan, 2007). Recognising and developing each facet with appropriate support allows subject learning to be constructed. The facets include: embarking on the enquiry, finding the information and evaluating its credibility, appropriately organising and analysing the information and finally, communicating in a discipline appropriate manner. By framing learning activities at the appropriate level, the RSD identifies explicitly, to both teacher and learner, what is required to demonstrate each facet and the level of support needed. Learners can be facilitated to develop autonomy and expertise in each facet by an iterative process.

A second feature of the RSD is the assessment rubric, based on the six facets and the appropriate level of autonomy, that accompanies each activity (see http://www.adelaide.edu.au/rsd/). RSD rubrics have been used as assessment tools, to track student learning and as a method of evaluating the RSD (Willison, Schapper & Teo, 2009; Willison *et al.*, 2010).

The RSD framework has been successfully used to determine initial critical reading skills and subsequent skills development in a first year Biology module (Peirce & Ricci, 2009). In addition, both an evaluative questionnaire and interview protocol are available (Willison *et al*., 2010). I decided to use these resources as the basis of my intervention to develop critical reading skills and to investigate my participants' views on research and enquiry to explore semi-quantitatively any impacts of the intervention.

Action research approach

At its simplest, action research involves identifying a concern based on personal values followed by planning an intervention to address the concern, implementation and reflection on the intervention leading to further cycles (McNiff, 2014). Interestingly, action research rejects neither positivist nor interpretivist approaches and sees both as compatible (Carr & Kemmis, 1986 p. 180); although there are differences in approach. Coghlan & Coughlan (2010) discuss the difference between empiricist positivist research and action-oriented research.

> *'...the contrast of roles [between positivist and action oriented research] is between that of detached observer in positivist science and of an actor and agent of change in action-oriented research (Coghlan & Coughlan, 2010 p. 194).*

The RSD framework is suitable for action research. Others, who have used the framework have reported improvements in their own teaching, improved dialogue with students and more reflection on teaching practice (Willison, 2012; Willison *et al*., 2010).

What I had not anticipated was the personal transformation that resulted from engaging in action research, that put me, albeit grudgingly, at the centre of the research activity. I discovered a different research perspective. I had come from a quantitative, empiricist science background and had no experience in qualitative, interpretative, nor educational research. I found the concept of action research both appealing and alien, simple yet elusive. I was attracted to the cycle of change, reflection, and adaption. However I found the perceived lack of objectivity, and the acknowledgement of my values challenged my previous perceptions of research. I worried about a lack of rigour. I realise now that I was experiencing and realising the differences between empiricist and interpretivist research as elucidated so clearly by Yilmaz (2013).

Slowly my perspective shifted. My initial approach was to use the first intervention as described by Peirce and Ricci (2009), together with a survey to discover objectively the baseline critical reading skill level of the students. Following the second intervention I planned to quantitatively determine any effect in order to make general extrapolations about the effectiveness of the RSD in developing independent learning. In fact, during the process, I shifted my position from being an outsider carrying out an objective project on a set of subjects to being immersed in a no less rigorous research experience where I, students and others, were all participants. When this insight emerged from reflection, reading and discussions with my supervisor and critical friends, I reformulated my research question and revisited my plan. I was not now determining objective measures of student attainment; I was now interrogating my own practice to help develop critical reading and academic writing skills

to aid a deeper approach to learning among second year Bioscience students as described by Biggs (1999). My research question was now:

> *How can I, with the collaboration of the second year Bioscience students, improve their research and enquiry skills so that they can use a research-oriented approach to discover more about microbiology?*

While my planned interventions remained the same, the aim of the survey was now to explore rather than measure impact and provide an opportunity to discover the students' perspective. I realised that action research demanded rigour and could accommodate a variety of approaches (Denscombe, 2010; McNiff, 2014; McNiff & Whitehead, 2011).

Relevance of the RSD to my situation

Prior to beginning the first diagnostic intervention based on Peirce & Ricci (2009), I enrolled on a small open online course (SmOOC) at the University of Adelaide (RSD Introductory Module). I explored the relevance of the RSD to my own teaching practice, reframed teaching activities in the light of the RSD and discovered the use and limitations of the framework in my own context. I saw clearer how my previous practice had contributed to students' lack of expertise in effective critical reading and subsequent independent learning and began to realise that I needed to change my practice.

My previous efforts had been ineffective, due to unrealistic and unclear expectations of what students could do. I posed the followed questions. Did I have clear objectives of what I wanted students to do? Was I just lazily asking students to "look it up" as an easy way to cover content? Did students really know what I expected of them or did I just assume that they would know? Did I give enough scaffolding to develop the skills for effective enquiry? Did I provide useful and timely feedback in a form that was easy to use? Could I perhaps build on students' pre-existing skills? Could I collaborate with other colleagues including those that gave communication modules and incorporate and extend these skills within the second-year microbiology module?

I realised the second-year Bioscience students needed skill development in critical reading and academic writing in a very supported and structured manner. I had neither been providing sufficient support to scaffold learning nor effective feedback on assignments.

Using the RSD I was able to clarify my teaching objectives of various microbiology topics and constructively align active learning activities with assessment as suggested by Biggs and Tang (2011). On a practical level, I was able to use the RSD framework to better prepare the detailed teaching plan and resources needed for the forthcoming diagnostic and following interventions based on Peirce and Ricci (2009). However I felt that the available summative assessment rubrics were not appropriate for my purposes and decided to use them formatively.

Outline of the interventions

The Bioscience group was small (37) and diverse: with a mix of school leavers, mature and international students. I felt there was mutual trust and rapport; I was their primary microbiology lecturer and had autonomy with respect to teaching strategies and assessment. To undertake the interventions I had support from my supervisor and Head of Department and from colleagues, both on the MATL programme and in my department. All provided me with practical, intellectual and emotional support and in some cases acted as critical friends.

The initial aim of the diagnostic intervention was to use RSD resources to demonstrate how well Bioscience students could summarise two articles on food safety. The material provided was credible and directly relevant to the module. The formative assessment rubric identified what was required for the task and the level of autonomy. Students were asked to use the rubric to self-assess their competency at the task (see Brazil, 2014, rubric available on request). I later provided general feedback in class and face-to-face feedback during practical sessions where discussions about the interventions took place.

I reflected on the intervention and incorporated modifications into the second cycle. The aim being, that having identified the principles of critical reading and academic writing students would engage in structured in and out of class reading and writing activities to discover the essential facts about food safety. All source material was provided. Students would demonstrate their learning of critical reading, academic writing and subject knowledge by submitting, online, a short assignment giving food safety advice to other students.

I did not make the assignment mandatory but encouraged engagement with the activities as a way of meeting an explicit assessable module learning outcome. However, I provided all students with a complete set PowerPoint© notes on the topic via Blackboard©.

Again a formative assessment rubric (available on request) was provided to support the activity and in this case feedback was provided via the Grademark© option of Turnitin©. The timing of the second intervention took place close to the end of term which affected class attendance, participation and submission of the assignment.

At the end of the final term prior to the examinations an online survey was sent to Bioscience students to explore their perceptions of research and enquiry and any impact the interventions may have had.

Impact on Bioscience students

It was important to discover if these changes in my practice to a supported research-oriented approach had any impact on the research and enquiry skills or the attainment of learning outcomes in the microbiology module. I looked for evidence of impact as recorded in my reflective diary, student assignments submitted, student feedback sessions, interpretations of the student survey and terminal examination results.

Bioscience students were willing to actively engage with and complete the initial diagnostic critical reading intervention which was held in class. As part of the intervention students were able to synthetize information gleaned from their reading and provide a descriptive title for their assignment. In addition students were able to explicitly state what they had learned about the topic. The one-to-one feedback sessions using the self and teacher assessment rubrics provided an opportunity for dialogue which allowed them to identify the skills they possessed and those that needed attention. Some students who did not engage with the first intervention, due to non-attendance subsequently engaged in the second more complex intervention and submitted the voluntary assignment despite the timing being close to the examinations. The associated assessment rubrics for both interventions demonstrated how the students, who submitted the assignments met the associated learning outcomes which required students to critically read, organise, analyse, synthesise, analyse and communicate material on the topic of food safety in an academic manner.

In the terminal microbiology examination all Bioscience students chose to answer questions on the topic of food safety, even those who had not submitted assignments. Material that had been autonomously learned was included in the examination answers. Previously I had found it rare that material from assignments would be included in terminal examination answers. This suggested a level of enduring learning of autonomously researched material.

Following the interventions and prior to the examinations I used an online adapted version of the RSD survey (Willison *et al*., 2010) to explore Bioscience students' perceptions of their own research and enquiry skills as identified on the RSD framework. Details can be found in Brazil (2014). The high response rate of 73%, (27/37) I feel showed good general engagement with the process of the interventions especially as students responded even if they had not submitted assignments. Using a 6-point Likert Scale Bioscience students demonstrated awareness of their own research and enquiry skills and the relevance of these skills in an academic and work context. 85% agreed or strongly agreed that *'Carrying out research / enquiry assignments helps me better understand the subject'*. 93% agreed or strongly agreed that '*The ability to enquire or research will be important in my career.'*

Open questions in the survey gave students an opportunity to recognise a range of research and enquiry activities throughout the curriculum. Not surprising, 67% (18/27) explicitly mentioned the interventions in the microbiology module. Students showed insight into their own learning and were able to explicitly identify the internal and external factors that helped them develop research and enquiry skills. Intrinsic factors included curiosity and previous experience (25%). External factors included the opportunity to practice the skills by doing assignments (67%), explicit research skills training and help by lecturers (25%). Interestingly only one respondent mentioned that feedback was helpful.

In addition, 15 respondents explicitly identified the factors that they felt hindered research and enquiry skills development. Again these included internal factors such as not knowing where to start (47%), time and workload issues (33%) and library/information retrieval issues (6%). Twenty per cent of students felt there was a lack of explicit guidance, including feedback, suggesting more supported interventions and feedback are required.

Participation in the interventions, including the survey, became an opportunity for students to recognise for themselves that they already possessed a set of useful research skills applicable to the microbiology module and beyond. They were able to identify and practice new skills that facilitated their independent learning.

Personal impact; lessons learned

On reflection, the interventions described above primarily resulted in a transformative shift in my thinking. I became more open to developing the capacity of myself, with the participation of colleagues and students to embed a research-oriented approach to learning in my teaching. The RSD framework became a tool that facilitated the examination of and the critical refection on my own practice in addition to aiding in critical reading skills.

To continue to address the question:

> *How can I, with the collaboration of the second-year Bioscience students, improve their research and enquiry skills so that they can use a research-oriented approach to discover more about microbiology?*

I need to ensure that I continue to build on participants' prior skills and knowledge, collaborate with others and continue to reflect on my own practice.

Build on participants' skills and knowledge

I recognised that each student group is unique, with their individual strengths and weaknesses and how essential it is to build on what students already know, to be where the student is (Brunner, 1977, p. ix). Despite learning, via feedback sessions and the survey (Brazil, 2014), that the group was not very confident about their critical reading abilities, they had a capacity to contribute to their own research skill development and hence independent learning. Many already possessed a range of critical reading strategies and could, when asked, articulate their learning needs in the area of research skills. They had an awareness, when surveyed, of what helped or hindered their own learning of research and enquiry skills and recognised opportunities to learn these skills and the importance of practice. I need to continue to acknowledge and build on their previous experience from school and other courses or other modules within the programme.

Contribution of colleagues

Social purpose is an important aspect of action research (McNiff & Whitehead, 2010, pp. 36-39). During the interventions described above I found that teaching can be, paradoxically, an individual activity. I am happy to discover a group of colleagues with a common interest in using research-orientated active learning strategies with whom I could collaborate I could collaborate. I find now that I am finding opportunities to interact more with colleagues than previously.

Continuing reflection on practice

Reflection on practice is an ongoing process and new insights continue to emerge, one being that I cannot address all my concerns at once. I feel I am beginning the process of developing research and enquiry skills in an undergraduate programme and the RSD model is useful. However active learning and research-based methods are time and resource intensive and require a change in teaching strategies. I don't feel that a totally research or problem-based method would suit my situation. I see an advantage of the RSD framework as it can be used at the assignment or module level; that different levels of student support can be given and it can be also used with conventional learning strategies such as lectures.

Clear and explicit expectations

At times I have had unrealistic and unclear expectations of what was required of the students and myself. I realised that the concept of academic writing and using credible sources can be challenging and confusing to early years students where learning passages off by heart is a successful exam strategy at school. I now acknowledge students' hesitation and lack of confidence when faced with the uncertainty of what a task requires. This compounds the practical difficulties they face when attempting learning activities. I also understand the competing time pressures especially as examination time approaches and how even formative assessment can be a burden if its purpose is unclear. I need to ensure that I always have clearly aligned learning objectives, activities and assessment. I feel the RSD model was a useful tool for making expectations explicit.

I found there were divergent expectations especially with respect to formative assessment which I saw as a low stake means of identifying learning gaps. A common perceived view among students is that it is not worth the effort if there are no marks, I feel a possible solution would be to be very clear as to the purpose of the assessment and the expected learning.

Developing independent learning skills is a process that takes time and progresses via incremental stages and this requires persistence and patience by all participants. I have been on occasions over ambitious and have not followed through with sufficient reflection. Small targeted interventions are more achievable.

Appropriate and relevant support and scaffolding

I feel that structured independent research activities helped students learn both subject specific knowledge and research and enquiry skills. In these interventions, the RSD allowed me to scaffold learning and provide formative assessment and feedback. I feel that I can adapt the model to reframe a range of further learning activities to suit the needs of different groups. I also consider more the nature of the support needed and the level of autonomy required.

Feedback that promotes reflection and dialogue

From a theoretical perspective I had learned the essential link between feedback and future learning (Gibbs & Dunbarr-Goddet, 2007; Gibbs & Simpson, 2004; Rust, 2002) and was aware of the principles of effective feedback (Nicol & Macfarlane–Dick, 2006). However it was only during these interventions that I fully appreciated that feedback can also provide an important opportunity for dialogue between learners and myself, as a means to facilitate the learning process as much as assessing students' knowledge and competencies. Others using the RSD have found that reflection is a feature of the framework (Willison *et al*., 2010).

In the first diagnostic intervention students used the rubric themselves to self-assess the level of their critical reading skills. When I discussed the differences between my assessment and theirs there was an opportunity to discuss issues in more detail as students often do not have realistic views both under and overestimating their abilities.

Despite issues, the RSD rubrics are a good guide in providing feedback and I feel meet the principles of effective feedback described by Nicol and Macfarlane-Dick (2006, p. 7). It was clear what was meant by good performance and learners were given the opportunity to reflect on their performance and see practical opportunities to make improvements. Moreover, I could see opportunities for further improving my practice and to be positive and encouraging. Due to time constraints, feedback on the more complex second intervention was provided via Turnitin© which was not as well attended to by students.

I consider that feedback allowed students to be more involved in their own learning as they could identify the skills they possessed, recognise what they need to improve and discuss how they can do so. They were potentially becoming more "self-regulated" learners as described by Nicol and Macfarlane-Dick (2006) following effective feedback. Willison *et al*. (2010), when evaluating the RSD, also found that students perceived classroom dialogue as very helpful. Despite the fact that students were happy to use the rubrics as a basis for feedback only one student in the survey stated that feedback helped develop their research and enquiry skills in contrast to the sixteen who said that completing assignments helped. This may indicate that this group had not had the opportunity to reflect fully on the link between feedback and improvement.

I have a dilemma reconciling the need to give useful feedback and the time required, both by me and the students. The real dialogue that occurs from face-to-face feedback was only possible because of the small class size. When I used online feedback via Turnitin© in the second intervention, a number of students did not attend to the online feedback, possibly due to time issues and the formative nature. In other modules when a mark is included more students look at the assignment via Turnitin©, but it is unclear if they read the feedback. I need to use strategies such as those suggested by Rust (2002) to make it worth their while to read and take on board feedback provided.

Formative assessment and effective feedback remains a challenge. Feedback mechanisms need to be adapted to the particular group and situation**.** I feel it is best to use a combination of general, personal online and face-to-face feedback opportunities. Above all, I feel I need to provide students with a reasonable number of opportunities to reflect on their learning and provide the appropriate support to practice new learning .

Appropriate assessment rubrics

Rubrics, while useful, require refinement in order to be an authentic assessment tool. Many of my concerns I found were reflected by Simpson and McKay (2013) where they discuss the challenges faced by teachers and learners when using rubrics. The assessment rubrics are an integral part of the RSD framework as a means of determining students' levels of autonomy or in measuring the attainment of learning objectives (Willison *et al*., 2010). However I found the modified rubrics were difficult to use with respect to assigning students to a particular level and felt they were better used formatively. I consider that the rubrics could be used in a very inappropriate instrumentalist manner.

Despite their limitations the rubrics were very useful in making explicit the intended learning objectives of the different facets of the critical reading activity and made it clear what was required. In the initial diagnostic reading activity, students could see broadly what level they were at with respect to each of the facets of critical reading. Interestingly I realised, for many students, the concept of expected criteria and associated rubrics was new and they found them useful to discover what was expected. I feel that getting students involved with setting the criteria as suggested by Rust (2002) would be even more useful in promoting deeper approaches to learning.

My conclusion is that that I must continue with the cycle of refining, implementing and evaluating the rubrics used .

Conclusion

The impact of undertaking and reflecting on the MATL programme has been transformative. I have not simply acquired a theoretical and practical toolkit to help me "teach " better. Moreover I have developed a more reflective mind-set, aided by keeping a reflective journal of discussions with others, that explores the potential dialogue in the teacher-student relationship. I have undergone a paradigm shift to 'the insider view' that examines how I can change my practice in the light of what I learn from my students and others.

Overall, I feel the interventions were worthwhile. With my help Bioscience students in intervention one became aware of the skills they might need to read effectively; in intervention two they were able to practise these skills to find out information from primary sources, make

organised notes and write a summary about food safety suitable for their peers. I feel that even students who did not complete the exercise fully and submit the assignment, engaged with the learning activities as seen by their performance in the end-of-year examinations and their response to the student survey.

I found that the RSD was a useful framework to introduce research-based skills that can be used to promote independent learning. I found that reframing learning activities into the 6 facets of research helped me clarify what learning was expected to occur in terms of both discipline and generic skills. It also promoted refection in myself and my students.

The findings of an action research project form the basis of future action in order to continue the cycle of change and learning. I hope that I can continue the process where we all strive together to learn about our practice and improve active student learning that will enable and empower students to construct knowledge from their own research.

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