ARTIGO ORIGINAL

AVALIAÇÃO COLABORATIVA PARA MELHORAR A MOTIVAÇÃO, A COMPETÊNCIA E A CONFIANÇA DE ESTUDANTES DA LICENCIATURA NO ENSINO DE CIÊNCIAS

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Resumo: Esta pesquisa foi desenvolvida como um projeto de pesquisa-ação participativa. A pesquisa-ação é uma abordagem que permite aos(às) professors(as) estudar suas próprias práticas pedagógicas e conduzir uma investigação de forma sistemática. Este artigo relata a implementação de um teste de domínio de conceitos de ciências, avaliado de forma colaborativa, e o impacto que teve no ensino e na aprendizagem de alunos(as)-professores(as) em um curso de curta duração em formação científica. O curso fazia parte de um programa de Diploma de Graduação em Ensino (Licenciatura) de um ano, já que os(as) professores(as) das escolas primárias da Nova Zelândia são generalistas. Seu ensino atinge uma ampla gama de assuntos para alunos(as) de 5 a 12 anos de idade. As estratégias de aprendizagem colaborativa beneficiam os(as) alunos(as) educacionalmente ao direcionar a influência do grupo de pares para se concentrar em questões intelectuais e substantivas. Os(as) alunos(as) desempenham um papel muito mais ativo na construção do conhecimento, primeiro nos pequenos grupos de especialistas de apoio, que mais tarde são colocados em prática em um grupo de conhecimento (comunidade de saberes) mais ampliado. Essa perspectiva sociocultural de aprendizagem posiciona os sujeitos como participantes ativos em um processo de transformação de sua compreensão em colaboração com outros sujeitos, em vez de adquirir conhecimentos e habilidades como propriedade ou ponto final de um indivíduo.
Palavras-chave: Colaboração. Formação de Professores(as). Estratégias de Aprendizagem. Comunidade de Saberes. Pesquisa-Ação Participativa.

COLLABORATIVE ASSESSMENT TO ENHANCE STUDENT TEACHERS' MOTIVATION, COMPETENCE AND CONFIDENCE TO TEACH SCIENCE

Abstract: This research was framed as a participatory action research project. Action research is an approach that enables practitioners to study their own pedagogical practices and to conduct an inquiry in a systematic way. This paper reports on the implementation of a collaboratively assessed mastery of science concepts test and the impact that it had on teaching and learning for student teachers in a short science education course. The course was part of a one-year Graduate Diploma of Teaching programme as teachers in New Zealand primary schools are generalists. Their teaching reaches a wide range of subjects to students from 5-12 years old. Collaborative learning strategies advantage students educationally by marshalling peer group influence to focus on intellectual and substantive concerns. Students take a far more active role in constructing knowledge firstly in the supportive small expert groups, which is later put into practice in a larger knowledge group. This sociocultural perspective of learning positions individuals as active participants in a process of transforming their understanding in collaboration with others, rather than acquiring knowledge and skills as a property or end point of an individual.
Keywords: Collaboration. Teacher Education. Learning Strategies. Knowledge Community. Participatory Action Research.

1 INTRODUCTION

A thematic concern underpinning my research is to improve student teachers' confidence and competence to teach science in primary schools. I am a teacher educator in a large university in New Zealand. In this paper, I report on the implementation of a collaboratively assessed mastery of science concepts test and the impact that it had on teaching and learning for student teachers in a short (24 hours contact time) science education course. The course was part of a one-year Graduate Diploma of Teaching (Primary) programme. Teachers in New Zealand primary schools are generalists – teaching a wide range of subjects to students from 5-12 years old. Science is taught relatively infrequently. This is due in part to the emphasis on numeracy and literacy in the primary school curriculum but also because teachers lack science content knowledge and the confidence to run successful science activities. Because student teachers see science taught so infrequently and/or poorly on practicum placement, they have little experience of what a dynamic learning area it can be in primary schools.

My role as the coordinator of the science education course was to ensure that graduating students not only knew what to teach but also how to teach science in ways that were relevant and authentic. I reviewed the academic passing rates and course evaluations from previous years. There were two issues that needed to be addressed. Firstly, there was a higher failure rate (particularly amongst Maori and Pacific Island student teachers) than in other courses. Secondly, absenteeism in the second half of the science course was noticeable. Student teachers were not engaging with the course material in a meaningful way. As the newly appointed course coordinator, I had the opportunity to revamp the course based on my understanding of the research literature around collaboration.

There is ample research evidence showing that students learn better through non-competitive group work than in classrooms that are highly individualised and competitive (for example the extensive works of BRUFFEE, 1999; JOHNSON; JOHNSON, 2004). An understanding that knowledge is socially constructed and that learning occurs among people is at the heart of collaborative learning and teaching. Johnson and Johnson (2004) emphasise positive interdependence in co-operative learning, which is linked to acceptance, support, trust, liking of peers and the exchange of information, oral rehearsal of ideas, mutual influence and high use of resources.

Intrinsic motivation is characterised by a high commitment and high emotional involvement in learning. This social engagement was illustrated by the student teachers' comments in McGookin's (2002) project. McGookin used a co-operative learning assignment in a compulsory educational psychology course for student teachers. Students reported to him that: "Group work gives me the motivation to keep producing good answers" (p. 424) and "It was important to have read over all of our other proposed answers so I didn't let others down" (p. 423). The collaborative nature of the assessment task was intended to motivate student teachers to attend to the subject matter knowledge in more detail and to teach one another through manipulating the social and emotional context. He found through his study "that the prudent structuring of student learning experiences to exploit affiliative motivation can produce behaviours normally associated with intrinsic motivation" (p. 417).

Collins, Harkin and Nind (2002) also found similar benefits of collaborative learning. The skills necessary to work collaboratively with peers are fundamental to engaging successfully in the teaching community.

> The process of peers working together to achieve shared goals, where there is individual accountability, corporate responsibility, shared leadership and positive interdependence, requires skilled and appropriate use of interpersonal skills. This necessitates the teaching, learning or practicing of a range of abilities in communication, the building and maintenance of trust, peer tutoring, leadership and handling controversy (COLLINS; HARKIN; NIND, 2002, p. 128).

Taking a responsibility for their own professional development and a commitment to life-long learning were goals encouraged through McCarthy and Youens' (2005) emphasis on collaborative peer-learning in a Postgraduate Certificate in Education course that they taught. There are numerous other authors who have claimed this and other benefits for collaborative learning which informed the implementation of the collaborative strategy in the science education course (see for example, ANGELO; CROSS, 1993; GILLIES; ASHMAN, 2003; JOHNSON; JOHNSON; SMITH, 1998; LOWERY, 2002; MICHAELSON; KNIGHT; FINK, 2002; PIERCE; KALKMAN, 2003; SMITH *et al.*, 2005).

In collaborative learning, group work often takes a large portion of time in a course. Because of this, group evaluation often becomes a necessary component of the grading system (HANSEN; STEPHENS, 2000). This raises the concern that using a group's output as

part of course assessment, and awarding equal grades to all members of the group, is seen as a weakness. This was a valid concern regardless of whether it was a capstone project or through combining scores in a test. It is reported that participation between students varies, with some putting in a lot of effort while others do a minimum (DIVAHARAN; ATPUTHASAMY, 2002). Gillies and Ashman (2003, p. 77) found that:

> When students believed that their contribution to a group was anonymous and could not be evaluated, they were more likely to engage in social loafing. … When students believe their contributions to a group are unique, they are less likely to free-ride on the efforts of their team mates.

Students often appear resentful of having to share grades with other students for assessments such as tests, but less so for group projects. Gillies and Ashman (2003) believe that this may occur because the scope of the project work is more complex and requires a team approach in which individual contributions are indispensable and unique. The rewards may be tangible, such as the group grade, or intangible, such as the intrinsic satisfaction of working together to co-construct knowledge. Encouraging the sense of indispensability can be fostered through making the task sufficiently difficult for students to believe they need to work together to accomplish it or to assess student's individual contribution to the group. Peer assessment can also be used to verify individual's actual work contribution in awarding individual grades on a team project (JOHNSON; JOHNSON, 2004; McGOOKIN, 2002).

Collaborative learning strategies advantage students educationally by "marshalling peer group influence to focus on intellectual and substantive concerns" (BRUFFEE, 1999, p. 92). An important goal of collaborative learning is "to hold students formally accountable for learning collectively rather than competing with one another" (BRUFFEE, 1999, p. 89). This can be accomplished using a number of strategies such as the jigsaw approach. (ANDERSON; PALMER, 1988; ARONSEN, 2000; MICHAELSON; KNIGHT; FINK, 2002).

Jigsaw is a well-known collaborative learning strategy that promotes positive interdependence. Typically, students are assigned home groups and each home group member is given the responsibility for accessing different information. Students then leave their home group to form expert groups which focus on the same information. Together, the experts develop their expertise and prepare themselves to teach the others in their home groups.

Experts return to their home group to share their particular piece of the jigsaw – hence the name. This strategy, as with other collaborative strategies, "shifts the locus of classroom authority informally from the teacher to the student groups" (BRUFFEE, 1999, p. 88).

Students take a far more active role in constructing knowledge – firstly in the supportive small expert groups, which is later put into practice in a larger knowledge group. This sociocultural perspective of learning positions individuals as active participants in a process of transforming their understanding in collaboration with others, rather than acquiring knowledge and skills as a property or end point of an individual (ROGOFF, 1998). She concludes that:

> Central to analysis of cognition as a collaborative process is a focus on the shared meaning in endeavors in which people engage in common. Cognition is not conceptualized as separate from social, motivational, emotional and identity processes – people's thinking and development is conceived as involved in social relations, with purpose and feeling central to their involvement in activities, and transformation of their roles as a function of participation. (ROGOFF, 1998, p. 729).

There was cautionary note in the literature too. Student teachers may react negatively to collaborative learning for a variety of reasons. They can have fixed ideas about university teaching as lecturing, and learning as memorisation of lecture notes in a competitive climate (PHIPPS; PHIPPS; KASK; HIGGINS, 2001). Students teaching one another does not always find favour, even with students of teaching. For many, the lecturer should be the font of all of knowledge. As Shor (1996, p. 67) wrote:

> Some [students] prefer rows because they would rather listen to teacher-talk than to student-talk; they consider the teacher a knowledgeable authority for whose wisdom they are paying good money; some also consider their peers boring, uninformed, or just plain dumb.

If active learning techniques are to be encouraged rather than the traditional passive learning often associated with the university classroom, their longer term benefits may need to be made more apparent. Cognizant of this research, I designed an assessment task to harness the potential of collaborative learning to master content knowledge and at the same time, practice teaching that content knowledge to their peers through a range of science activities.

2 METHOD

Action Research is an approach that enables practitioners to study their own pedagogical practices and to conduct an inquiry in a systematic way (McNIFF, 2017). This research was framed as a participatory action research project - a lens through which I was both inside practice and research. Kemmis and McTaggart (2005, p. 563) wrote that:

> Participatory action research involves the investigation of actual practices and not abstract practices. It involves learning about the real, material, concrete and particular practices of particular people in particular places … Participatory action research differs from other forms of research in being more obstinate about its focus on changing particular practitioners' particular practices.

My focus was to enhance the confidence and competence of student teachers to teach science through the implementation of a collaboratively assessed science content and pedagogy test. This intervention was designed to motivate and encourage student teachers to teach one another, to develop a familiarity with resources and to develop their subject and pedagogical content knowledge base in ways that encouraged active learning – both about science concepts and teaching science. An eight question theory and pedagogy test was implemented as an assignment weighted 40% of the course grade. The test focused student teachers' attention on the importance of, and increased their motivation to learn, science subject matter.

The eight questions covered the most common and important ideas in teaching science at primary school level. Each question asked student teachers to outline the main science concept and two appropriate activities to engage learners. The questions were given to everyone during the first session and students were told that in the final theory test, any four of eight of these questions would be asked. One of the reasons why the science theory test had a pedagogical focus was that science teaching can be perceived of as the transmission of information with limited understanding on the teacher's part. Many student teachers have limited subject matter knowledge and limited opportunity to see learners actively engaged in constructing deeper understanding of science in primary classrooms, or for themselves. It was hoped that by focusing on appropriate activities which would engage learners, that the task would be elevated to more than the mastery of low level science content.

The student teachers were instructed to work collaboratively in self-selected groups of four. They were encouraged to teach and learn from each other. Within the groups it was expected that each student teacher would select two of the eight questions on which to focus as per the jigsaw strategy. In the first iteration, student teachers were not specifically directed to form expert groups, but nor were they discouraged from sharing information between groups. They were to teach their two topics (or parts of the jigsaw) to the other three in their group and to provide them with ideas, activities and questions that would make learning the topic effective, memorable and successful. It was anticipated that each student teacher would be motivated to learn aspects of the curriculum in depth so that they could then teach others in their group.

An incentive to learn and support each other within their group and to engender positive interdependence and individual accountability was that in the final test each student teacher answered only one question. The members of each group were given a combined score. Questions in the actual test were assigned randomly so that the possibility of any student teacher answering one of the two questions they had personally researched was left to chance.

Student teachers' evaluation of this assignment was generated through their final course evaluation and through focus group interviews after the course was completed. I also kept a professional journal for the duration of the project spanning 2 cohorts.

3 RESULTS

The results of the student teachers' evaluation pertaining to the collaboratively assessed test across two years are summarised in **Table 1**. In total, 78/83 students responded to the questionnaire in Year 1 and 90/ 91 in Year 2 of the study. Overall, more students rated the strategy positively. For example, 60% (Year 1) and 70% (Year 2) agreed or strongly agreed that collaboration was a positive aspect of the task and 60% of respondents thought that all members had contributed equally. In the second year of the study, twice as many students (63% compared to 32%) were positive about their individual mark being dependent on the group. The assignment was successful in giving students practical ideas to use in the classroom (91% agreed in Year 1 and 85% in Year 2).

Table 1 – Student teachers' evaluation of Assignment 2 (n = 78)

Assignment 2 (Theory/Collaborative Assessment)	**Strongly agree (%)**		**Agree (%)**		**Neither (%)**		**Disagree (%)**		**Strongly disagree (%)**	
	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2
1 Assignment 2 has given me practical ideas to use in the classroom	35	48	56	37	8	4	4	9	0	2
2 Working collaboratively was a positive aspect of this task	25	27	35	43	15	16	13	12	12	2
3 All members of the group contributed equally	30	32	30	28	12	11	22	23	6	7
4 I am happy to have my mark for this assignment dependent on others in group	3	15	37	48	28	14	13	16	19	6

Source: Research data.

Fifteen student teachers participated in informal interviews about the science module after the final evaluation. Here, I have selected representative comments that reflect a range of opinions. Most of them commented that they had enjoyed the jigsaw strategy and said that they would use the idea of experts to teach their peers in their own classes. However, many made the point that they would not use a group grade to assess this. For example, in two of the interviews I recorded that student teachers had said the following:

- The joint mark in class wouldn't work. When you're reporting to parents, having a joint mark is difficult. Kids don't have the maturity and it's too high stakes. You need to have practice at working collaboratively. (Student interview: Pr. and Ma.)
- They would use the strategy in class but not the test. They questioned the validity – professionally could you justify this to the parents? (Student interview: Tr. and Em.)

Collaborating had been effective in motivating the student teachers to learn the subject matter as indicated by the following comments:

> • At the beginning the strategy felt terrible, but it did make them sit down and learn. They learnt from their peers, they had a handout aligned to the questions and just learnt them. Retained it better. (Student interview: Me. and Vi.)
> • [Pr. and Ma.] Loved the collaboration, thrived on it, and enjoyed it. It meant less work but they didn't want to let others down, they didn't care about own mark. (Student interview: Pr. and Ma.)
> • [Sa.] didn't feel pressure to pass, the pressure was off because she scored enough in the first assignment to pass the module but it was a funny feeling – not wanting to be the weak link so she was still motivated. (Student interview: Sa.)
> • They were freaking out – but they all knew they were capable of doing well. They would be prepared to wear a lower mark if someone bombed out because they had all worked really hard. They would be happy because they had all worked together. (Student interview: Tr. and Em.)

Several student teachers commented in individual interviews that they enjoyed summative assessment and the pressure to perform. In these examples, student teachers implied that they would have preferred to work individually.

> • [An.] would have liked 90 minutes and to do all eight questions. He says he would have done well, likes studying for tests, wants knowledge at his fingertips, and wants to cram. He likes right and wrong answers. Summative assessment with high stakes lifts your game. He gets a kick out of studying and doing well. It's a challenge to achieve a good grade, likes having earned a good grade. Individually, he has scored A+'s, only in group work does he score less than that. (Student interview: An.)
> • [Is.] thought it might have been good to do two questions in 45 minutes. She was confident doing any question. She thought assessment has to be transparent. She preferred traditional summative assessment – doing a test

> and getting good grades. She liked learning from the board and got satisfaction out of doing assignment well. (Student interview: Is.)

The student teachers were not so enthusiastic about the group grade and I wondered whether they thought I could justify the group grades for them. Many of the student teachers who spoke to me were highly motivated high-achievers and enjoyed the challenge of learning information for summative assessment. They saw group participation as a liability rather than an asset. In the end of the course evaluations there was an alternative opportunity for students to comment on any aspect of the content, delivery or assessment. There were as many positive as negative comments about the assessment strategy including, for example, these positive comments:

- The collaborative learning is great. Most effective was the fact that we had to teach our group and assess them.
- I do think the collaborative strategy works well and really enjoyed and learned a lot from bouncing ideas off others.

And these negative ones:

- Assignment 2 was a complete waste of time. It has not increased my knowledge of science, nor has it increased my ability to teach science. Having to learn 8 questions and assessed on 1 – crazy!
- Ability to rote learn 8 questions (typical student behaviour).

4 MODERATING FINAL GRADES

The student teachers' perception that a group grade would be a liability was not borne out by the final results. Student teachers had commented that being part of a group had made them work harder because they did not want to be seen as the weak link. This determination resulted in nearly 60% of each cohort passing with an A grade and the quality of the student teachers' answers was very high overall. No student teachers scored less than 50% in this assessment task in either year.

At the moderation meeting lecturers had discussed how grades would be awarded to those individuals who had scored either considerably more or less than others in their group. There were groups in each class that required an adjustment of the marks to ensure that individuals were not unfairly penalised or rewarded by the group grade. The determining factor was whether the raw group mark would change an individual's final grade from one grade band to another. Through negotiation, a standard procedure for adjustment was decided. If an individual scored 2 marks differently from others in their group, they had their own score multiplied by 4 and the others in the group had their marks combined and adjusted to give a total out of 40. The extent to which lecturers felt confident exercising their professional judgement was curtailed by the difficulty they had in knowing what had taken place within the group meetings and peer-teaching. Lecturers had little way of accurately assessing individuals' participation or contribution to a group grade. The difficulties student teachers had envisaged in the interviews in justifying group grades to parents were already familiar problems for lecturers.

5 DISCUSSION

The collaboratively assessed science content and pedagogy test served multiple purposes. One minor commendation was the reduction in marking that occurred because we only required students to answer one question as indicative of their knowledge. Anecdotally, student attendance improved with minimal absenteeism even towards the end of the course. This was only evident through a cursory head count since taking a register of attendance is not considered appropriate at the University. The reasons why there was a noticeable increase in

attendance were not clear but it could have been because there was a greater sense of belonging and affiliation to others in the class. Certainly there appeared to be more social connection prior to sessions starting and at their conclusion. It is self-evident that those who attended classes were able to engage in the science activities, share ideas with peers, ask and answer questions of the teacher and actively participate in learning as opposed to those who did not attend sessions. Collaboration, as it was tied to the mastery test, applied pressure to coax extra study of subject matter knowledge out of the student teachers in their busy schedules. An improvement in grades for the cohort was also noticeable and the fact that there were no failing students in either years was an indication that students were, on the whole, successful.

However, I acknowledge that accurate subject matter does not necessarily equate to confidence to teach science. My assumption was that helping student teachers to construct accurate personal subject matter knowledge would lead to greater confidence and competence in teaching but this was not validated by the straightforward implementation of the test. In fact, there were more apparent gains in confidence when student teachers took the opportunity to prepare lessons and teach one another the science concepts. In the first year, some students did this of their own volition. In the second year, I made 30 minutes of the 2-hour block of time available to the students to teach one another during the session. This modification was well received by the student teachers who were conscientious in giving one another constructive feedback about the quality of the resources and material that their "teacher" taught. Introducing peer-teaching during standard sessions reduced the amount of time each lecturer had to teach. Shifting the control and focus from the lecturer to the teaching-student caused some discussion between staff members who were concerned that the course was already time-short and content heavy. It seemed antithetical to "give up" any time but I argued that student teachers needed to be more actively engaged in learning to teach rather than learning science. As teacher educators, we needed to ensure that this happened.

Whether or not these strategies of collaboratively assessing a content test or peer teaching impacted on student teachers' perception of confidence and competence is a moot point. Since they were implemented as a suite of modifications it is not possible to evaluate their outcomes individually. Improving subject content knowledge through the mastery test, marshalling peer pressure to ensure student teachers paid due attention to detail for the sake of

the group grade and regulating peer-teaching in class, all combined to improve student teachers' confidence and competence to teach science. All student teachers passed the course successfully. All bar one of them agreed that their confidence to teach science had improved over the course and all of them claimed that they were enthusiastic about teaching science in the final evaluation.

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