

The perspectives of lecturers on the action research journey in the Mathematics and Science Department of Singapore Polytechnic

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Abstract The goal of this research was to understand the various aspects of the action research initiative in the Department of Mathematics and Science, Singapore Polytechnic. A total of 55 lecturers took part in this study and data were collected through semi-structured questionnaires, informal conversations with the lecturers, observations of their behaviours in action research processes and evaluation of their action research reports. Statistical methods and grounded theory were used in the analysis. Statistical analysis showed that the lecturers generally perceive that action research is useful in teaching and learning. The core category of ‘Taking personal and professional ownership in action research’ was formed through grounded theory analysis. Through addressing the various sub-categories in the core category of ‘Taking personal and professional ownership in action research’, a number of recommendations to improve the current situation of action research implementation in the department were proposed.

Keywords Action research · Professional ownership · Personal ownership · Grounded theory

1 Introduction

In 2007, Singapore Polytechnic announced a career structure framework for academic staff to assist them in moving towards careers that tap on their strengths and capabilities. The career structure framework consists of three paths: management, teaching and technology. One of the requirements for lecturers who choose to stay in the teaching path is to equip themselves with relevant and up-to-date pedagogies.

The role of the Department of Mathematics and Science (MS) is to support the various engineering and business schools in Singapore Polytechnic in terms of mathematics, information technology and science education. MS has been incorporating active learning approaches

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such as conceive–design–implement–operate (CDIO) skills, problem-based learning (PBL) and information technology in teaching and learning (ITTL) into the mathematics, science and information technology modules. Based on the emphasis of active learning, the department sees the potential of action research (AR) in serving as an effective platform for its lecturers to:

- (a) explore and implement new active learning ideas and methods in teaching and learning;
- (b) assess the effectiveness of these active learning ideas and methods;
- (c) decide on whether any effective active learning approaches can be included in the curriculum.

Therefore, action research was then identified in April 2008 in the MS departmental work plan as a core activity to enhance the quality of its curriculum.

A focus group was thus set up to spearhead the action research initiative in the department. Training sessions (by invited external action research experts or own colleagues) were conducted for the lecturers in the areas of action research. Guidance in the forms of readings and onsite assistance were also provided by the action research focus group. Till now, most of MS staff had gone through three cycles of action research. 62 action research projects (21 action research projects in 2009/2010 Semester 1, 23 action research projects in 2008/2009 Semester 2 and 18 action research projects in 2008/2009 Semester 1) were completed. These projects were mostly collaborative in nature.

The department-wide implementation of action research was met with differing reactions from the lecturers. These reactions were observed to be either positive (enthusiasm, interest, support, etc.) or negative (scepticism, cynicism, resistance, etc.). However, the reasons behind these positive or negative reactions were not known. These reactions could be instrumental in affecting the effectiveness and sustainability of the action research initiative in the department. Therefore, there was a pressing need to understand the experiences of the lecturers in the initiative. At the same time, it would help the department to chart its continuing journey of the action research initiative usefully.

2 Research aims

The aims of this research were twofold. First, it attempted to gauge the extent action research is viewed positively or negatively by the lecturers and, to find out the reasons behind such reactions. Second, it aimed to explore means to improve the action research processes in the department.

3 Research questions

To achieve the above two aims, two research questions were formulated as below.

- (a) To what extent is the action research initiative in the department viewed by the lecturers as positive or negative to teaching and learning, and why?
- (b) How can the action research initiative in the department be further improved on the basis of advancement in teaching and learning?

4 Literature review

In this literature review, a brief introduction to the history and types of action research was given. It also gave an overview of the pros and cons of conducting action research in educational settings. Finally, the factors that influence the processes of action research would be discussed too. The literature review would be useful to the researchers in the conceptualisation of the research processes.

Action research originated from Kurt Lewin, who first coined the term around 1944. He perceived that the analysis of research has the potential to lead to social actions to address unjust scenarios in the real world (Burns 2005; Greenbank 2007). Action research is conceptualised to be a continuous spiral of planning, action, observing, evaluation and reflection (Kemmis and McTaggart 1988; Zuber-Skerritt 1993; Burns 2005; Greenbank 2007). Action research can be conducted in the social, economic, industrial, military, political and educational domains. According to Calhoun (1994), action research can be done individually, collaboratively or school-wide.

In the field of education, three types of action research are identified—*critical action research* and *practical action research* (Kemmis 2001) as well as *technical action research* (Kemmis 2001; Rearick and Feldman 1999). Critical action research, that is the original intent of Kurt Lewin, aims to uphold social justice of education through promoting social improvement under the umbrella of equal and democratic educational practices. It attempts to understand educational practices politically, socially and economically. Thus, it is emancipatory and participatory, or even confrontational, in nature. Practical action research adopts a context-dependent research that aims to understand the thoughts, feelings and actions of the stakeholders in the pedagogical interventions conducted. Such studies contribute to the advancement of educational theories and are achieved through qualitative research methods. The last type of action research, known as the technical action research, emphasises on a scientific and experimental approach and it stresses on the cause and effect evaluation of pedagogical interventions conducted. This is achieved through the use of quantitative research methods (Kemmis 2001; Rearick and Feldman 1999). While most of the Mathematics and Science action research projects are of the technical type, there are a few that (for example, this project) is of the practical type.

The role of action research in educational settings has grown to be undeniably important in recent years. There are many studies that investigated on the usefulness of action research in education. Zuber-Skerritt (1993) believed that action research advances knowledge in education, improves the practice of the practitioners by developing them as personal scientists and professionals, and transforms the educational institutions into learning institutions. Since teachers are instrumental in bringing educational institutions to a higher level, Carr and Kemmis (1986) claimed that action research has to be primarily concerned with the development of teachers' practices. Wells (1994) and Calhoun (1994) stated that teachers can use action research as a powerful tool to change from within through empowerment of themselves and their students. Besides, teachers who conduct action research tend to be motivated, creative, confident and student-centred in their teaching (Greenbank 2007). Action research also promotes the culture of self-evaluation among teachers regarding their teaching (Schatz 1993). Teachers can also be consciously aware about the discrepancies between their values and their classroom practices through action research. At the same time, action research allows the teachers to develop their own educational theories through translating them into practice (Whitehead 1993). It is generally agreed that action research brings many benefits such as inheriting a set of repertoire of skills that are useful for practitioners in their professional practices (Kemmis and McTaggart 1988) and the ability to promote social change

and school reforms (Hursh 1995; Kemmis and McTaggart 1988; Cochran-Smith and Lytle 1990; Calhoun 1994). However, Borg (2002) questioned if action research consistently leads to better teaching practices. Hollingsworth (1996) noted that conducting an action research within the teaching and learning context means that the teacher researcher has to do a delicate balancing act between the need of research and the need of students.

From the above studies, it may be concluded that action research can play an important part in teaching and learning. However, the above studies were not conducted in the context of Singapore. Thus, this study could help to fill up the gaps in the relevant literature, by understanding if action research did play a role in improving teaching in the department.

Cochran-Smith and Lytle (1993), Goodnough (2008), Jones (2004), Rainey (2000), Sardo-Brown et al. (1995) and Whitehead (1993) discussed on the factors that influence the effectiveness of action research processes. Sardo-Brown et al. (1995) identified six major barriers in conducting educational action research: teachers' anxiety surrounding the perceived technical nature of research, differential status (university lecturers vs. teachers), lack of ownership, perceptions of treating different groups of students unfairly due to intervention, sensitivity of issues if the intervention does not turn out positive and institutional resistance. In his assessment of action research, Wallace (1991, p. 56, in Burns 2005) stated: 'To do research properly requires special expertise, a lot of time, financial resources and perhaps particular personal traits, for example, an academic bent, etc.' Teachers who do not perceive themselves as researchers are more likely to resist against conducting action research (Jones 2004). It becomes more difficult to get the commitment of teachers in collaborating in action research if they do not see it as important or relevant (Greenbank 2007). In the study of Rainey (2000), the factors that influence the success of implementing an action research by a teacher include the amount of time given, level of relevant training provided, level of collaborative support and level of encouragement from colleagues and management. Goodnough (2008) did a study on 39 science teachers who used action research in their practices over a 3-year period and reported that the teachers found the same issues mentioned above challenging.

In summary, this literature review showed that this study could help to fill up the gaps in the relevant literature where it is found lacking in the context of Singapore. At the same time, it would assist in the formulation of questionnaire and serve as resources for the improvement of the action research processes in the department.

5 Methodology

5.1 Introduction

This research employed selected quantitative and qualitative research methodologies that are effective in the collection and analysis of relevant data under the constraints posed by the context of this research.

5.2 Data collection and analysis

This study employed survey research as its primary source of data collection (DC). The survey questionnaire comprised two types of DC. In the first type of DC in the survey questionnaire, the respondents were to reply to a series of questions through a six-point Likert scale ratings that elicited lecturers' perceptions that spanned over three consecutive semesters. Such

retrospective approach aimed to understand the changes with regards to the implementation of action research in the department from its inception till now. More importantly, in the questionnaire, the respondents were requested to write down their thoughts and feelings with regards to the each set of the Likert scale rating questions. Such a partial open-ended response approach managed to generate about 40 pages of meaningful comments from the 55 respondents (out of 59 surveyed) and uncover other issues unrelated to the two research questions. One limitation in this mode of DC was that data collected from the respondents were retrospective in nature and hence susceptible to recall bias. Two examples of both types of DC are shown below.

To what extent has my action research made me reflect on my teaching practice?						
	To a very great extent	To a great extent	To some extent	To a small extent	To a very small extent	Not at all
AY 08/09 Semester 1						
AY 08/09 Semester 2						
AY 09/10 Semester 1						
Why?						

Please list down the issues that you feel strongly about the conduct of action research in the department but are not brought up in the survey.

Other secondary forms of data included the three researchers' informal conversations with their colleagues engaging in the action research processes, observations of the behaviours of their colleagues in action research processes and, evaluations of their colleagues' action research reports.

Quantitative data from the Likert scale response questions were analysed through descriptive statistics and hypothesis testing. As for the qualitative data, the data analysis (DA) techniques of grounded theory research were employed in this study. Grounded theory is a mode of inductive analysis that is derived from or 'grounded' in everyday human experiences within a given context (Glaser and Strauss 1967; Strauss and Corbin 1998). Grounded theory thus, allows a researcher to understand the experience of humans from their perspectives within the environment they are in (Grbich 1999). The action of constant comparison is important in grounded theory research. The method of constant comparison ensures that each piece of relevant data is continually compared with every other piece of relevant data to generate theoretical concepts that encompass as much behavioural variation as possible (Glaser and Strauss 1967).

For quantitative data, simple descriptive statistics were used to represent the information. The analysis on association was done using a non-parametric test, so no assumption need to be made regarding the data. Thus, reliability and validity of data were achieved in this study. As for the qualitative analysis section, in grounded theory research, the consistent use of constant comparative method would have ensured trustworthiness of the research (Strauss and Corbin 1998). Memos used in the research process helped to corroborate the data collected. The triangulation of data sources, theoretical saturation, member checking, comparison of results with relevant reviewed studies and the presence of an audit trail further improved the trustworthiness of the research.

6 Findings

6.1 Attitudes towards action research

The first four questions in the survey questionnaire were formulated to find out if action research are perceived either positively or negatively by the respondents in terms of teaching and learning over the course of the three semesters they were involved in conducting action research. The analysis of these four questions helped to shed light on the former part of the first research question: 'To what extent is the action research initiative in the department viewed as positive or negative by the lecturers to teaching and learning, and why?' The four questions in the questionnaire were:

- (1) To what extent has my action research made me reflect on my teaching practice?
- (2) To what extent has my action research helped to improve my teaching practice?
- (3) To what extent has my action research helped me to understand how my students learn?
- (4) To what extent has my action research helped my students learn in my class?

The above four questions were formulated based on the literature review in relation to the aims and advantages of conducting action research in school settings (Hursh 1995; Kemmis and McTaggart 1988; Cochran-Smith and Lytle 1990; Calhoun 1994; Zuber-Skerritt 1993). These authors generally believed that action research helps teachers to reflect and improve on their teaching. At the same time, they also perceived that action research allows teachers to understand and enhance student learning. Although the effects of action research on the respondents might not be restricted to the domains of teacher reflection, teaching and student learning, this study had focused on the above four domains. This was because all the authors above considered these four domains as important benefits of conducting action research.

These four questions helped the researchers to understand if the respondents' perceptions towards action research are positive or negative and if the perceptions have changed over the three semesters. As such, to reflect the change of respondents' perceptions throughout the three semesters accurately and reliably, they were required to reply to each of the above questionnaire questions through a six-point Likert scale as below.

To a very great extent	To a great extent	To some extent	To a small extent	To a very small extent	Not at all
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However, the classification of the category of 'To some extent' as either a positive or a negative response had to be addressed in the analysis of the data since this category could be ambiguously positive or negative from the respondents' perspectives. Therefore, the accompanying comments from the respondents who marked the response 'To some extent' were further analysed to determine its positivity or negativity (in relation to the four questions) in the context of this research. There were 70 positive and 11 negative accompanying comments to the four questionnaire questions (for respondents choosing the category of 'To some extent') that were related to action research in teaching and learning. In this regard, the following assumptions were maintained in this study:

- (a) Since the ratio of positive comments to negative comments was nearly 7:1, it would reasonably be assumed that the response category 'To some extent' for the first four questions could be perceived as positive.
- (b) The other response categories, 'To a great extent' and 'To a very great extent' would also be defined as positive responses as all such respondents had commented positively on the four questionnaire questions.

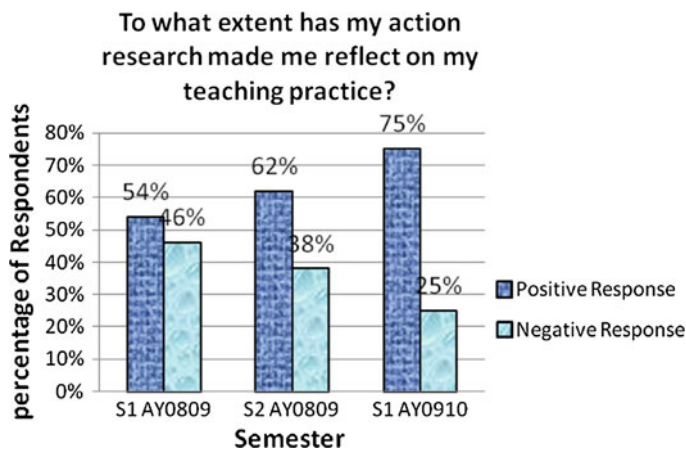


Fig. 1 Increase (decrease) in the positive (negative) respondents for Question 1

Table 1 Number of positive and negative respondents for Question 1

	S1 AY0809 (out of 47 respondents)	S2 AY0809 (out of 52 respondents)	S1 AY0910 (out of 52 respondents)
Positive respondent	25	32	39
Negative respondent	22	20	13

- (c) As for the categories of ‘To a small extent’, ‘To a very small extent’ and ‘Not at all’, they would be considered as negative responses in this study as most of these respondents added negative comments to the four questionnaire questions.

6.1.1 Lecturers’ perceived responses of action research towards their teaching

This section would elaborate on the analysis of the data collected from the first two questionnaire questions pertaining to the respondents’ perceptions of action research on their teaching. The number of perceived positive responses in S1 AY0809 was taken as the base for comparison.

(1) *To what extent has my action research made me reflect on my teaching practice?*

From Fig. 1, it was gathered that the proportion of staff who responded positively that action research helped them to reflect on the teaching practice had changed from S1 AY0809 to S1 AY0910. The percentage of positive respondent in S1 AY0809 was 54% (based on 47 respondents) whereas in S1 AY0910, it was 75% (based on 52 respondents). Also, from Table 1, it could be noted that the number of negative respondents decreased from 22 to 13.

There were three respondents who rated that action research had not helped them at all in reflecting their teaching practice in the first cycle. However, by the third cycle, two out of three respondents rated that action research helped them to reflect on their teaching practice to a small extent and the third respondent rated that action research helped him/her reflect on his/her teaching practice to some extent (converted to a positive respondent). No one rated action research as not helping them at all in reflecting their teaching practice by the

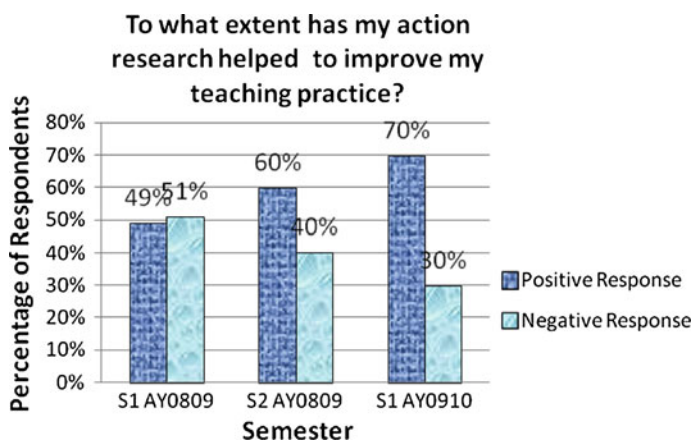


Fig. 2 Increase (decrease) in the positive (negative) respondents for Question 2

Table 2 Number of positive and negative respondents for Question 2

	S1 AY0809 (out of 47 respondents)	S2 AY0809 (out of 52 respondents)	S1 AY0910 (out of 54 respondents)
Positive respondent	23	31	38
Negative respondent	24	21	16

third cycle. This is a significant and positive note as action research has always aimed at encouraging all academic staff to be reflective teachers, no matter the extent.

There were eight respondents who initially responded negatively to this question switched their responses to positive responses by the third cycle. No one altered his/her responses from positive to negative in the same period.

Selected supporting qualitative data related to the use of action research in helping the respondents to reflect on their teaching practice are shown below:

- It allows me to consciously understand what is happening in my teaching.
- It makes me more conscious of my teaching and reflect on how to improve. AR does help to raise awareness to existing problems or teaching difficulties.
- To reflect and improvement of practice.
- The outcome after implementing the AR made me reflect on my teaching practice. AR allows me to reflect on my practice not only from lecturer's points of views.

(2) *To what extent has my action research helped to improve my teaching practice?*

From Fig. 2, it was gathered that the proportion of positive respondents who believed that action research helped them to improve their teaching practice was almost equal with that of the negative respondents in S1 AY0809 but by the third cycle, the proportion of positive respondents was greater than the negative respondents. In S1 AY0910, 70% (based on 54 respondents) of the staff responded positively that action research improved their teaching practise as compared to 49% (based on 47 respondents) who responded positively in S1 AY0809 (Table 2).

Out of the entire negative respondents in the first cycle, ten negative respondents had converted to that of positive respondents by the third cycle. Two of these ten respondents

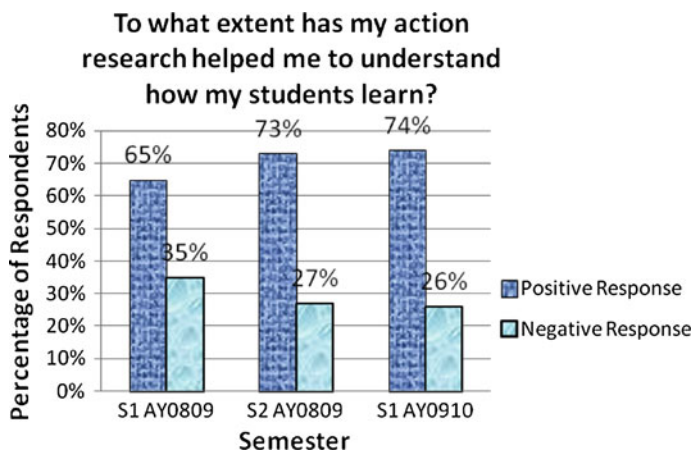


Fig. 3 Increase (decrease) in the positive (negative) respondents for Question 3

who initially responded that action research has not helped at all or only to a very small extent to improve their teaching practice, have changed their responses to that action research has helped them to some extent improve their teaching practice by the third cycle (converted to positive respondents). Only one of all the respondents had switched from viewing positively that action research in the first cycle to negatively by the third cycle.

Selected supporting qualitative data in this aspect are shown below:

- Having AR, a lecturer will think harder to consistently improve on learning and aiding his students to learn better.
- It also provided me with alternative forms of teaching and/or facilitating in a classroom environment. It challenged me to try different ways of teaching, learn from mistakes and improve on my goals of achieving the learning outcomes along the way.
- ...and do systematic study on the effect of some teaching practice. ...seriously think of what to and how to improve my teaching and learning skills.
- ...experiment with new teaching practice.

In summary, questionnaire Questions 1 and 2 are related to the teachers' perceived benefits in conducting action research with respect to their teaching. Both the questions garnered an increase of more than 22% of positive respondents over the course of three semesters.

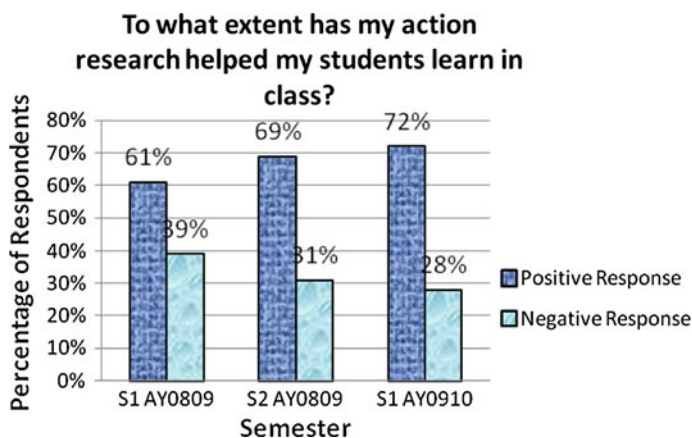
6.1.2 Lecturers' perceived responses of action research towards their student learning

This section would elaborate on the analysis of the data collected from the next two questionnaire questions pertaining to the respondents' perceptions of action research on their student learning.

- (3) *To what extent has my action research helped me to understand how my students learn?*
From Fig. 3, it was gathered that in all three cycles, the proportion of staff who responded positively to action research helped them to understand how their students learn, might seem to have only a slight change (possibly be due to the fact that a large proportion

Table 3 Number of positive and negative respondents for Question 3

	S1 AY0809 (out of 46 respondents)	S2 AY0809 (out of 51 respondents)	S1 AY0910 (out of 53 respondents)
Positive respondent	30	37	39
Negative respondent	16	14	14

**Fig. 4** Increase (decrease) in the positive (negative) respondents for Question 4

of the staff already perceived action research positively in this question from the first cycle) (Table 3).

However, it is encouraging to note that, from the staff who responded negatively to this question in S1 AY0809, ten of them switched their negative responses to positive responses by the third cycle. Only two staff who switched their positive responses in the first cycle to that of negative responses by the third cycle. There is still an overall increase in the net rate of conversion from negative responses to positive responses.

Selected supporting qualitative data in this aspect are shown below:

- Use AR platform to assess and obtain feedback.
- AR gave a chance for me to collect feedback from students. Some project requires collection of students' feedback on how the methodology adopted in the AR helped them learn. For such case, we are able to get info about how they learn.
- Had a better understanding of their style of learning from their feedback.
- DA helped me to understand how my students learn.

(4) *To what extent has my action research helped my students learn in my class?*

From Fig. 4, it could be gathered that the proportion of positive respondents to the question that action research helped their students learn in their classes changed from 61% (based on 46 respondents) to 72% (based on 53 respondents) (Table 4).

There were seven negative respondents who converted to responding positively that action research helped their students learn in class by the third cycle and only one respondent who switched from responding positively to this question in the first cycle to negatively by the third cycle.

Table 4 Number of positive and negative respondents for Question 4

	S1 AY0809 (out of 46 respondents)	S2 AY0809 (out of 51 respondents)	S1 AY0910 (out of 53 respondents)
Positive respondent	28	35	38
Negative respondent	18	16	15

There were five respondents who rated that action research had not helped their students learn in class at all in the first cycle. However, only one of the five responses remained unchanged in the third cycle, whereas two of the five agreed that action research helped their students learn to some extent in the class. The other remaining two respondents did not complete the survey in the third cycle.

Selected supporting qualitative data in this aspect are shown below:

- ...students are involved in activities which require them to create tests, quizzes and puzzles, they are learning more.
- Activities improve learning.
- Helped me to explain the some concepts to the students and the students can understand them better.
- We have investigated students learning habits if AR implemented effectively, there may be some positive impacts on learning habits and motivate them.

In summary, questionnaire Questions 3 and 4 are related to the lecturers' beliefs of the benefits in conducting action research for their students' learning. Both the questions garnered an increase of at least 9% of positive respondents over the course of three semesters.

6.1.3 Further analysis on effects of AR on teaching and learning

Through synthesising and comparing both sets of data in the preceding two sections, some observations are made below:

- In the context of this research, questionnaire Question 1, 2, 3 and 4 could represent the lecturers' perceptions on the effects of action research on their teaching and learning. In general, there was percentage increase of lecturers who viewed action research positively by the end of the third cycle of action research (S1 AY0910). This could mean that a number of the respondents do perceive action research as beneficial to both teaching and learning by S1 AY0910.
- It could also be seen from Table 5 that the rate of increase in the positive responses surpassed the rate of decrease in the negative responses. This could plausibly be attributed to the minimal resistance towards the action research initiative by the new staff who joined the department and were engaged in AR projects, as well as possible buy-ins from the existing staff.
- Although there was a significant overall increase in the percentage of positive respondents, as shown earlier, Table 6 shows that there are approximately 25–30% of the respondents who still view action research negatively. The subsequent analysis could help to shed some light on this matter.

Table 5 Number of respondents who changed their opinions about AR by the third cycle (only respondents who completed the survey for all three cycles were considered)

Questionnaire questions	Number of respondents who switched from viewing AR negatively in the first cycle to positively by the third cycle	Number of respondents who switched from viewing AR positively in the first cycle to negatively by the third cycle
(1) To what extent has my action research made me reflect on my teaching practice?	8	0
(2) To what extent has my action research helped to improve my teaching practice?	10	2
(3) To what extent has my action research helped me to understand how my students learn?	5	1
(4) To what extent has my action research helped my students learn in my class?	7	1

Table 6 Number of negative respondents in S1 AY0910 to the questionnaire Question 1–4

Questionnaire questions	Number of negative respondents to the questionnaire questions in S1 AY0910
(1) To what extent has my action research made me reflect on my teaching practice?	13 out of 52 (25.0%)
(2) To what extent has my action research helped to improve my teaching practice?	16 out of 54 (29.6%)
(3) To what extent has my action research helped me to understand how my students learn?	14 out of 53 (26.4%)
(4) To what extent has my action research helped my students learn in my class?	15 out of 53 (28.3%)

6.2 Factors that affect attitudes towards action research

The second part of the first research question ‘What are the underlying factors that may influence the reactions of the lecturers towards the action research initiative in the department?’ would be addressed in this section. From the qualitative analysis, an overarching category was identified—*Taking professional or personal ownership in action research*.

This overarching category was created through the analysis processes of grounded theory. Open, axial and selective coding in grounded theory were utilised in the analysis process (Strauss and Corbin 1998). Open coding involves the labelling and categorisation of phenomena as indicated by the data. Coding does not entail the mini descriptions of the different blocks of data but to capture the meanings of theirs instead. As for axial coding, those assembled data are put back together in fresh ways by making associations between a category and its subcategories. This is to bring together the categories and subcategories in explaining the phenomenon/phenomena that are in the data investigated. Finally, selective coding refers to the integration of the categories to structure the initial theoretical framework so as to ana-

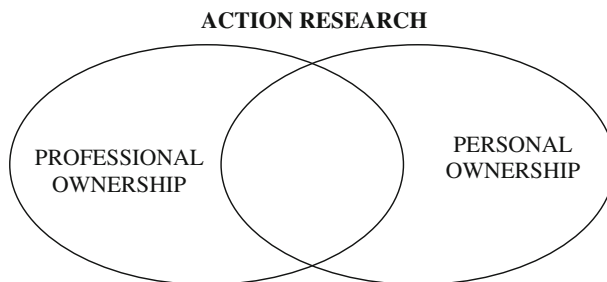


Fig. 5 Professional and personal ownership in action research

lytically come up with the grounded theory from the data. The process of memoing (Strauss and Corbin 1998) is conducted concurrently with the three forms of coding.

In this study, when lecturers take ownership in action research, they consider action research as part of their personal or professional growth. By taking professional ownership, the lecturers acknowledge action research as a part of their work duties and they do it to fulfil their professional obligations. On the other hand, by taking personal ownership in action research, the lecturers believe the importance of action research in effective teaching and learning and do it willingly regardless of its relationship to their professional duties. It is possible for a lecturer to take both personal and professional ownership in action research. The act of taking ownership in action research translates into lecturers' types and strengths of attitudes towards action research. And their level of professional or/and personal ownership in action research affects their outputs in terms of teaching and learning (Fig. 5).

The core category of 'Taking personal and professional ownership in action research' encompasses four main categories of personal factors: 'Level of proficiency in conducting action research', 'Level of belief of the usefulness of action research', 'Level of interest in conducting action research' and 'Level of enjoyment in conducting action research'. They are interrelated and influence one another. These four main categories work together in determining the level of the lecturers' ownership of the action research (professional, personal or both) undertaken by them. These four main categories are further influenced by six other subcategories that are mainly related to departmental policy issues in the action research initiative.

These six subcategories include 'Level of guidance', 'Level of clarity of action research direction', 'Time factors', 'Differences in staff academic backgrounds and action research knowledge domain', 'Compulsory nature of action research initiative' and 'Evaluative nature of action research initiative'. They in turn affect the level of attainment in the four main categories and thus the level of professional or personal ownership in action research eventually. The diagrammatic representation of 'Taking personal and professional ownership in action research' is shown in Fig. 6. The subsequent sections would elaborate on, and illustrate the various main and sub-categories and their interrelationships.

6.3 Main categories of personal factors

This section would elaborate on the four main categories of personal factors: 'Level of proficiency in conducting action research', 'Level of belief of the usefulness of action research', 'Level of interest in conducting action research' and 'Level of enjoyment in conducting action research'.

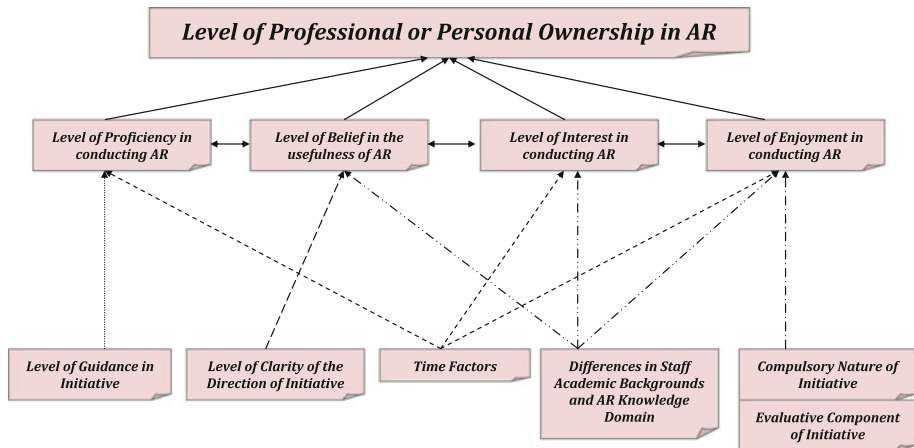


Fig. 6 An overview of the ‘Taking personal and professional ownership in action research’

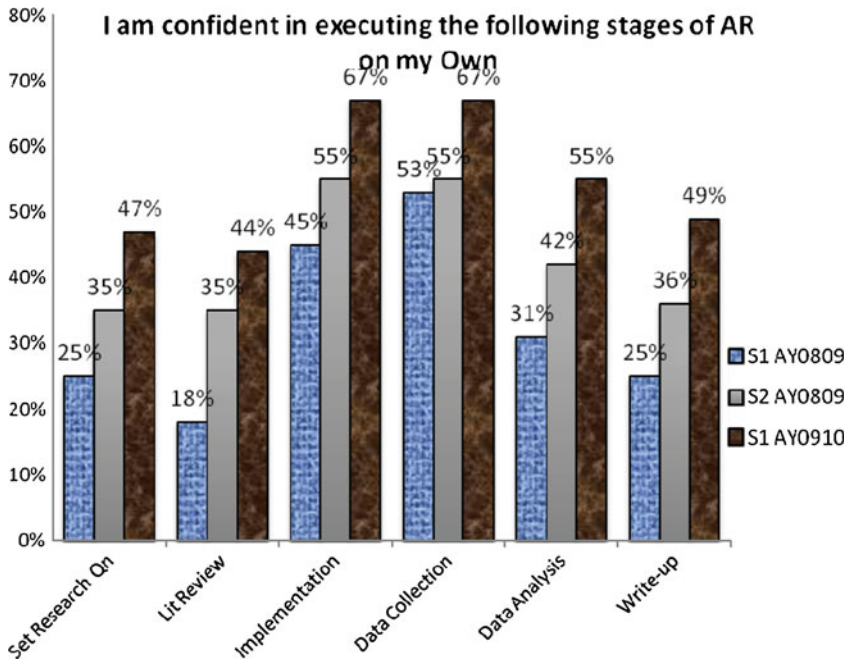


Fig. 7 Percentage of confidence of respondents in executing various stages of action research, over the course of three semesters

One important limitation of the qualitative analysis process is that the analysis relied on the data found in the survey and no follow-up could be carried out to clarify about any created concepts or issues due to the anonymity of the survey. Therefore, there were instances in the analysis below where certain concepts were related to others but the reasons of their relationships were not explained.

Table 7 Number of staff who are confident in executing various stages of action research in S10809 (first cycle of AR in the department) and S10910 (third cycle of AR in the department)

Various stages of action research	Number of staff who answered that they are confident in executing the various stages of action research in S10809	Number of staff who answered that they are confident in executing the various stages of action research in S10910
Setting research questions (RQ)	14	26
Literature review (LR)	10	24
Implementation (Imp)	25	37
Data collection (DC)	29	37
Data analysis (DA)	17	30
Write up of report (W)	14	27

6.3.1 Proficiency in executing action research processes

From the DA below, the level of proficiency the staff have in conducting action research processes may have influence on level of ownership. The bar chart below demonstrates the change in the respondents' perceived level of confidence level in conducting action research processes over the three semesters. In this study, the respondents' level of confidence is assumed to be synonymous to their level of proficiency in doing action research (Fig. 7, Table 7).

The overall confidence of the respondents in conducting action research can be further supported by the increase in the number of submissions or presentations in conferences or journals from 5 in 2008 to 13 in 2009. Two of four researchers who are also the evaluators of all the action research projects completed in the three semesters agreed that there are marked improvements by the staff in executing the different stages of action research as shown in their action research reports.

Those lecturers who maintain high levels of professional ownership in action research may not show lower levels of proficiency in executing action research as compared to those who show personal ownership in action research. It may also be hypothesised that the level of proficiency in executing action research processes is positively related to the level of interest and enjoyment in doing action research.

6.3.2 Level of belief in action research

The respondents' perceived level of their belief of the effectiveness of action research in affecting teaching and learning also influence their level of personal or professional ownership in action research. There is a substantial number of respondents (12 out of 55) who believe that action research is useless in teaching and learning. Their resistance towards the action research initiative was also very strong. Their scepticism about the usefulness of action research was evident in their survey responses. Below are some of the comments made by the respondents with regards to the above factor.

- I do not think my action research made me reflect on my teaching practice.
- I did reflection on my teaching all the time and AR contributed very little in this area as far as I am concern. One or two AR will not help you much.

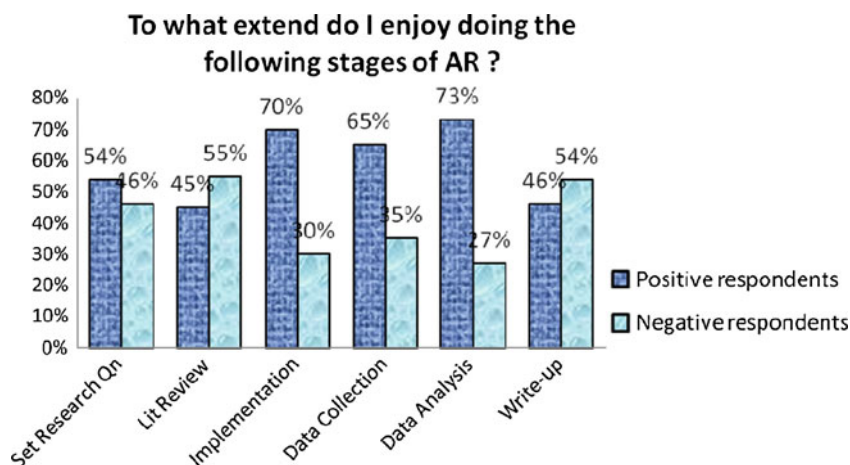


Fig. 8 Percentage of level of enjoyment of respondents in executing various stages of action research

- Sorry to say that. My whole exercise was meaningless to me.
- My reflections on my teaching practice have little to do with action research. I do not need 'research' to reflect on my teaching practice. Research has little to do with it. It is just a 'fad' like 'teach less, learn more', 'IDEA' etc. which will fade over time.

6.3.3 Level of interest

The lack of interest on the part of the staff in doing action research can be a contributing factor in the type of ownership assumed by them in action research. Below are some of the comments made by the respondents with regards to the above factor.

- Interest is not there.
- There are plenty of team members joining AR team just to fulfil quota without any interest in the AR topic.
- For AR to be meaningful, we need to get interested, excited so that we would go to search and read up another paper.
- Research should be 'PASSION' driven.

6.3.4 Level of enjoyment in executing action research processes

Another possible reason related to the lecturers' adopted forms of ownership in action research is related to how much they like executing the action research processes. From the Fig. 8 and Table 8, it can possibly be perceived that they do not enjoy the processes of 'Setting research questions', 'Literature review' and 'Write up of action research'.

The reasons for the above are found in the qualitative data. They are as follows:

- (a) Setting research questions:
Reasons for non-enjoyment

- (i) Inability to fully understand the process of setting research questions (lack of close guidance).

Table 8 Number of positive and negative respondents in the various stages of action research

	Setting search questions	Literature review	Implementation	Data collection	Data analysis	Write up of AR report
Positive respondents	28	24	38	35	40	24
Negative respondents	24	29	16	19	15	28

- (ii) Running out of research areas due to the need to produce one report in each semester.
- (b) Literature review
Reasons for non-enjoyment:
 - (i) Lack of time for reading.
 - (ii) Time consuming nature of reading literature.
 - (iii) Inability to fully understand the process of reviewing literature.
 - (iv) Dislike of reading.
- (c) Write up of action research
Reasons for non-enjoyment:
 - (i) Lack of time for writing.
 - (ii) Lack of confidence in writing.
 - (iii) Time consuming nature of writing up.

The association between respondents' confidence and enjoyment in executing various stages of action research project were analysed. To facilitate a neater analysis, respondents were considered to be confident in executing a particular stage of action research project if they have indicated their confidence in that action research stage for at least one cycle of action research project. Respondents' levels of enjoyment were captured using a six-point Likert scale—'to a very great extent', 'to a great extent', 'to some extent', 'to a small extent', 'to a very small extent' to 'not at all'. Respondents who indicated their responses as 'to a very great extent', 'to a great extent' or 'to some extent' were considered to have enjoyed executing the indicated stage of action research project whereas respondents who indicated 'to a small extent', 'to a very small extent' and 'not at all' were considered to have not enjoyed the indicated stages of action research. Then, the Spearman's ρ was used to analyse the association between respondents' levels of confidence and their levels of enjoyment in executing the various stages of action research project, shown in Table 9.

There is a high association ($\rho = 0.84$) between respondents who enjoyed the stages of DC and DA. This is further supported by qualitative responses of staff who commented that they enjoy applying new theories, are eager to find out whether the new initiative was successful, are interested to read students' feedback and like to use new tools in analysing data obtained. Although there is a high level of association between confidence in implementation (Imp) and DC ($\rho = 0.637$), there is a low level of association between confidence in Imp and confidence in DA ($\rho = 0.18$) as well as confidence in DC and confidence in DA ($\rho = 0.26$). This could imply that if a respondent is confident in implementing an intervention and collecting data of the new intervention in the classroom, the respondent may not be equipped with the necessary skills in analysing the data collected. This inference is further supported by com-

Table 9 Spearman's rank coefficient correlation between respondents' confidence and enjoyment in executing various stages of AR

	Confident in this stage of AR						Enjoy this stage of AR					
	RQ	LR	Imp	DC	DA	W	RQ	LR	Imp	DC	DA	W
Confident in this stage of AR												
RQ	1	0.54	0.21	0.38	0.33	0.39	0.17	0.11	0.16	0.17	0.21	0.39
LR		1	0.16	0.33	0.36	0.40	0.18	0.38	0.21	0.01	0.16	0.38
Imp			1	0.64	0.18	0.42	0.04	−0.04	0.27	−0.05	0.03	0.19
DC				1	0.26	0.35	0.10	0.24	0.10	0.04	−0.01	0.24
DA					1	0.49	0.16	−0.06	0.17	0.09	0.21	0.23
W						1	0.22	0.06	0.34	0.04	0.18	0.61
Enjoy this stage of AR												
RQ							1					
LR							0.28	1				
Imp							0.21	0.21	1			
DC							0.01	0.29	0.32	1		
DA							0.05	0.28	0.44	0.84	1	
W							0.28	0.27	0.42	0.29	0.39	1

ments such as lacking in education research background and training, no proper guidance in DA as well as insufficient time to thoroughly think through the whole process. Another significant finding from Table 9 is the level of association ($\rho = 0.54$) between confidence in setting research questions (RQ) and confidence in conducting literature review (LR). This high-level association actually links low levels of confidence in these two stages. Respondents commented that setting research questions is the toughest, they do not know what words to type onto Google to start researching for literature and how to evaluate and further refine the research questions and generally, they lack time to search for and read the literature to formulate proper research questions. More insightful analyses are done in the next section.

6.4 Subcategories

The six subcategories include 'Level of guidance', 'Level of clarity of action research direction', 'Time factors', 'Differences in staff academic backgrounds and action research knowledge domain', 'Compulsory nature of action research initiative' and 'Evaluative nature of action research initiative' would be elaborated below.

6.4.1 Level of guidance in conducting action research

Respondents felt there is an insufficient amount of guidance when they are conducting their action research. At the same time, it has to be noted that there is a lack of action research proficient staff (currently there are only three staff in the action research focus group) to support the whole departmental action research initiative. The lecturers' levels of proficiency and enjoyment in executing action research are strongly influenced by this factor. Below are some of the comments made by the respondents with regards to the above factor.

- The love for research must be encouraged and proper support to be provided.
- More support and time to be given.
- The AR focus team to conduct workshops to help teams set questions, provides more assistance to team to write the report.
- Lack of guidance, we do not have people to turn to when we need help.

6.4.2 Level of clarity of the direction of action research initiative

The lack of a focused direction and future plans of the action research initiative in the department may be an issue here too. As action research is a new initiative, lecturers see the importance of the presence of clear directions from the action research focus group. This factor can influence the lecturers' level of belief of the usefulness of action research. Below are some of the comments made by the respondents with regards to the above factor.

- In my view, such a thrust is badly lacking in our approach to AR.
- Quite difficult to think about new ideas every semester. 'Dryness' and 'saturation' point will be reached easily.
- The entire department, must work towards common objectives.
- We all end up researching on the same issue.

6.4.3 Time factors in doing action research—lack of time and time consuming nature of doing action research

There are respondents (33 out of 55) who strongly feel about the time issues in doing action research. Although, most of them are not aversive to action research, they feel that action research is extremely time consuming. They exhaust their energies in designing, implementing, collecting data, analysing data and putting up formal action research reports. Each staff also has to complete one action research individually or collectively per semester. This can lead to the lack of time in completing action research. Another factor that leads to the lack of time is the heavy teaching workload of each staff other than doing action research. Below are some of the comments made by the respondents with regards to the above factors.

- The reason is that time devoted to AR was too small. There is no time to reflect. Also I need time to read others' work/papers and possibly I can reflect on my teaching practice. To do serious AR, more time is required. alas I do not have time! Please give us more time!
- Not enough time allocated to do the necessary review. Sometimes, it is just done in a 'rush' when time is insufficient.
- It is the sheer lack of time to search and read and reflect.
- AR is a time consuming I have spent a lot of my time in AR. More time should be given to those who are interested in doing AR.

Table 10 shows the descriptive statistics on the amount of time spent on action research in terms of hours and days for all three semesters.

Responses in terms of days indicated that half the respondents spent more than 10 days on AR project each semester (median = 10). On the other hand, responses in terms of hours revealed that half of the respondents spent more than 35 h on AR each semester (median = 35). Most of the AR projects were conducted collaboratively, usually in teams of two to four people.

Table 10 Descriptive statistics on the amount of time spent by a staff on an AR project in any given semester

	Days	Hours
Mean	14.16	57.98
Median	10.00	35.00
Range	57	192
Minimum	3	8
Maximum	60	200

Note: Each respondent only answered in terms of hours *OR* days, therefore, the respondents who answered in terms of hours are not the same as those who answered in terms of days

6.4.4 Differences in academic and action research domain backgrounds

Not every lecturer has the ability to conduct the processes of action research. As most of the lecturers are engineering- and science-trained instead of social science-trained, they have encountered a lot of challenges in doing action research which is in the domain of social sciences. This factor can influence the lecturers' level of belief in the usefulness of action research and interest and enjoyment in executing action research processes. Below are some of the comments made by the respondents with regards to the above factor.

- I lack *EDU/AR background* and thus do not completely enjoy reading such papers.
- I have no background in education...
- This is something new for me, hence I am not used to the style of a pedagogy research.
- New to AR. Steep learning curve.

6.4.5 Compulsory nature

There are respondents (14 out of 55) who view action research as being a compulsory departmental initiative to be done regardless of their preference. Although there are respondents who believe in the usefulness of action research, they feel psychologically bounded by this fact that they have no say in the whole initiative. This can affect the lecturers' level of belief of the usefulness of action research and, proficiency, interest and enjoyment in executing action research processes. Below are some of the comments made by the respondents with regards to the above factor.

- Do not make AR compulsory.
- We are forced to do it!
- We are doing it for the sake of doing it.
- It will be an ideal situation if AR is made optional.

6.4.6 Evaluative nature

As part of the departmental policy, the conduct of action research constitutes 10% of each staff's performance assessment every academic year. This is one of the reasons for the formation of negative attitudes towards action research. This can affect the lecturers' level of belief of the usefulness of action research and, proficiency, interest and enjoyment in executing action research processes. Below are some of the comments made by the respondents with regards to the above factor.

- Putting AR as a one semester PMP (performance assessment) goal (that has rigid deadlines and deliverables) takes the joy out of conducting AR for the purpose of becoming a good teacher.
- When taken as a PMP (performance assessment) goal, very often this leads to a very obligatory attitude.
- Make changes to the measurement criteria—allow for mistakes.
- Remove the ‘rubrics’ (evaluation) as it is too demanding.

7 Discussion and recommendations

The lecturers in this study generally agreed that action research is useful in teaching and learning. They also have acknowledged that there are unique factors that influence processes of action research. These factors surfaced in the core category of ‘Taking personal and professional ownership in action research’ formed in this study. It encompasses four main categories of personal factors: ‘Level of proficiency in conducting action research’, ‘Level of belief of the usefulness of action research’, ‘Level of interest in conducting action research’ and ‘Level of enjoyment in conducting action research’. These four main categories are further influenced by six other subcategories that are mainly related to departmental policy issues in the action research initiative. These six subcategories include ‘Level of guidance’, ‘Level of clarity of action research direction’, ‘Time factors’, ‘Differences in staff academic backgrounds and action research knowledge domain’, ‘Compulsory nature of action research initiative’ and ‘Evaluative nature of action research initiative’. These six subcategories with the exception of the categories of ‘Compulsory nature of action research initiative’ and ‘Evaluative nature of action research initiative’ are somehow similar to the obstacles in conducting action research as mentioned by the authors below.

In his assessment of action research, Wallace (1991, in Burns 2005) and Rainey (2000), correctly identified that action research requires special expertise, time and personal interest. These factors are similar to the main categories of ‘Level of proficiency in conducting action research’ and ‘Level of interest in conducting action research’ and the subcategory of ‘Time factors’ that have evolved in this study. Sardo-Brown et al. (1995) stated that teachers’ can be caused by the perceived technical nature of research. This is similar to the subcategory of ‘Differences in staff academic backgrounds and action research knowledge domain’ in this study. The main category of ‘Level of belief of the usefulness of action research’ is synonymous of the fact that teachers do not like to conduct action research if they do not see action research as important (Greenbank 2007). Rainey (2000) also confirmed that the levels of relevant support and training provided in the area of action research are also influential in affecting the success of action research. The subcategory of ‘Level of guidance’ in this study supported the above conclusion. Goodnough (2008, p.446) did a study on 39 science teachers who used action research in their practices over a 3-year period and reported the following issues: *time factor* (39 out of 39 found time lacking in doing AR), *formulation of research questions* (22 out of 39 found it challenging), *data analysis* (20 out of 39 were uncomfortable with it), *write-up* (20 out of 39 found time lacking), *adherence to AR timeline* (17 out of 30 faced difficulty), *resources/support* (14 out of 39 found it lacking) and *school support* (7 out of 39 felt a lack of it). Except for the last issue (lack of school support), most of these are also issues faced by the respondents. In short, the literature had supported most of the analysis done in this study.

A unique issue not discussed in the above literature arises because of the presence of the categories of ‘Compulsory nature of action research initiative’ and ‘Evaluative nature of

action research initiative'. It is due to the context of this research where the whole initiative was carried out department wide without any choice of not doing it by the lecturers. What happened due to this unique arrangement is in contradiction of what [Sardo-Brown et al. \(1995\)](#) claimed as the obstacle of institutional resistance. In the context of this study, instead, the MS management is totally supportive of this action research initiative such that they use action research as one of the measuring means in the lecturers' work appraisals. Such move in making action research as a measuring yardstick in work appraisals may complicate things here. Due to the risks in terms of their work appraisals and incentives, it can be perceived that the 25% of the lecturers who do not believe in action research at all, has to exercise at least a minimum level of professional ownership in action research in order to satisfy their work requirements. Thus, they may be taking low levels of professional ownership in action research. This may, in turn, cause tension between the management and them (as similar to the study of [Cochran-Smith and Lytle \(1993\)](#)). This is a delicate issue that needs to be addressed.

From the results of the analysis, this article proposes that the level of personal and professional ownership in action research in the department has to be addressed. By achieving that, three issues that arose from this research can be addressed at the same time:

- (a) The whole departmental action research implementation structure can be further fine tuned.
- (b) The 25% of staff who respond negatively to action research can hopefully see action research in more positive light.
- (c) The current 75% of the staff who respond positively to action research can be further supported and strengthened in their journey in action research.

Although, an ideal scenario would be for all staff to take personal ownership in action research, it would be impossible to achieve this goal at the moment. Therefore, it is envisaged that a more realistic option is to increase the level of professional ownership in action research by addressing the intervening obstacles to improving effectiveness of action research in the department. Thus, the lecturers' 'Level of proficiency in conducting action research', 'Level of belief of the usefulness of action research', 'Level of interest in conducting action research' and 'Level of enjoyment in conducting action research', have to be improved. This also means that the underlying influencing categories of 'Level of guidance', 'Level of clarity of action research direction', 'Time factors', 'Differences in staff academic backgrounds and action research knowledge domain', 'Compulsory nature of action research initiative' and 'Evaluative nature of action research initiative', have to be addressed. The recommendations below serve to reduce or remove the six underlying influencing categories above:

- (a) To have a core group of interested action research advisers to support initiative.
 - These action research mentors staff will be trained by the action research focus group in the areas of educational research.
 - Each of these staff will help support individual action research.
- (b) To set clear directions and aims in action research initiative.
 - Setting different themes for action research in different semesters.
 - Briefing staff on the short-term and long-term aims of action research.
- (c) To set up an institutional Educational Research Team to undertake meaningful institutional level studies extended from individual action research.
- (d) To reassess the evaluative component of action research initiative.

- Setting up alternative assessment means such as
 - Involving in communities of practice.
 - Presenting in conferences or seminars.
 - Maintaining semestral teaching reflection portfolios.
 - Doing theoretical research.
 - Involving in externally funded educational research.
- (e) To allocate more time for action research.
 - Allowing action research to be completed over two semesters or more as long as justifications are valid.
 - Allocating a reasonable amount of time off for action research that are done well.
 - Doing action research over alternate academic year or semester.
- (f) To conduct further training in action research proficiency areas found lacking for general population of lecturers.
 - Coming up with a structured training programme in improving action research competency.
- (g) To address the compulsory nature of doing action research by giving more alternative choice of improving learning and teaching (such as developing educational tools) as the action research initiative aims to achieve.

It is hoped that the above recommendations can address the second research question, 'How can the action research initiative in the department be further improved on the basis of advancement in teaching and learning?' Currently, a number of recommendations above are adopted in the implementation of the action research initiative in the new semester.

Looking beyond Mathematics and Science Department, the recommendations above can also serve as a possible form of policy study for any other organisations that may be considering embarking on action research at institutional level to improve their organisational capabilities. These organisations can consider adopting or customising some of the above recommendations that may be relevant to their contexts so as to implement their action research processes more effectively and efficiently.

8 Conclusion

This study has shown that the complexities of action research are not restricted to teaching and learning. It involves other political, social and personal issues. Therefore, a great amount of effort and understanding are required from all stakeholders if action research is to be effective in education. However, there is no foolproof solution to make action research work perfectly in education yet. And in this department that has adopted action research as a method to improve learning and teaching, it is hoped that the journey would prove to be meaningful one in the near future.

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