Journal of Science Education Vol.25 n◦ 1 2024

Journal of Science Education

ISSN 0124-5481

Level of Knowledge, practices and challenges of physics practical work in secondary schools: the case of Pawi k2v2 and Gilgel Beles secondary school Metekel zone Benishangul Gumuz regional state, Ethiopia.

Semeneh Bedemo (Ass.Pro) [a]

a.Department of natural science, Gilgel Beles College of teachers' education

ARTICLEINFO

Keywords:
challenges
practices and Knowledge

ABSTRACT

Practical work forms an integral part of teaching and learning as enshrined in the teaching physics syllabus designed for secondary schools. This study therefore aimed at examining teachers' level of physics practical work knowledge, practices of physics practical work teaching and challenges of implementing physics practical work in classrooms. It considered students (grades 9 and 10), physics teachers and principals of Pawi K2V2 and Gilgel Beles secondary schools in the academic year of 2013/2014. Using probability proportional to size, 151 and 104 students were selected from grades 9 and 10 respectively. The total sample size was 264 (255 students, 4 principals and 5 teachers). The design for the study was a survey type guided by three research questions. The research questions were answered using descriptive statistics while any significant differences in responses were tested using Mann-Whitney U and ANOVA tests from the data collected through questionnaire and interview. Cronbach's alpha indicated significant internal consistency between PWI questionnaire on declarative, procedural and conditional knowledge. The result showed that teachers' level of declarative, procedural and conditional knowledge was low or absent. Hence, this study suggested that teachers need professional development opportunities on practical work. The percentage analyses of questionnaire from teachers and principals indicated low level of practices of practical work teaching. Mann-Whitney U test showed no significant differences between the responses of grades 9 and 10 students on level of practical work teaching. Students' (grades 9 and 10) and principals' responses regarding challenges of practical work teaching on ANOVA test showed no significant difference (p=0.168) between grades 9 and 10 students while that of the principals' was significantly different from students' responses (p=0.000). The results of interview and open ended questionnaire indicated low level of teachers' knowledge of cognition, lack of skills and interest in identifying and applying the practical work, insufficient amount of time, large class sizes, lack of laboratory facilities and lack of teachers professional development were appeared to be challenges of physics practical teaching in those schools. Based on the findings of this study, recommendations were made. Initial training and continuous professional development of physics teachers should prioritize teaching of practical physics. The physics curriculum should be reviewed to explore reduction of content to allow teachers spend time on practical activities. Government funding should be allocated to build, equip and maintain adequate school laboratories. Teacher motivation should be enhanced by recognition of success in the delivery of practical physics
.

1.Introduction

1.1. Back ground of the study

According to Trivedi and Sharma (2013), science is a great human and proofs, statistical reasoning, suspended judgments, acceptance of warranted conclusion and willingness to change opinion in the light of new evidence are the ferments which characterize the scientific enterprise.

Natural scientists examine matter, energy, and motion as well as how they interact with one another in space and time. This field of research is called physics, Larcher, D., & Tarascon, J. (2015). Acquiring a foundational understanding of scientific inquiry techniques is one of the main objectives of studying Physics; this will help planners solve problems more effectively and advance their careers Kunisch, S., Denyer, D.& Cardinal, L. B. (2022).

Corresponding author:Semeneh Bedemo (Ass.Pro)
Email:semenehb31@gmail.com
Accepted 1 July 2024, Available online 3 December 2024

According to NTI (2007) physics as a subject is activity oriented and the suggested method for teaching it is guided discovery method and is resource based. This suggests that the mastery of physics concept cannot be fully achieved without the use of instructional learning materials. The teaching of physics without learning materials becomes a challenge in any education environment, resulting to poor performance.

While the world is developing rapidly through the application of science and technology, students' interests in physics were diminishing at all levels of education (Fischer and Horstendahl, 1997). Physics become less preferred subject among the students. As a result, fewer and fewer students in Colleges and Universities selected it as their major subject (Fischer and Horstendahl, 1997). Therefore, it is becoming a must that the models of teaching of science and physics must be reformed and improved in such a way that it can attract learners to join this field of study.According to Black (1993), given the sciences including physics are applied fields; the best ways to learn about them are through experiments, observations, analysis, and conclusion generalization. According to Kulik (1992), a practical work approach to science training in secondary schools is necessary to emphasize the understanding of physics and other sciences by all students. There are various approaches used in school to complete practical work (Wellington, 1998). Practical work is defined as "any science teaching and learning activity where students observe and/or manipulate the objects or materials they are studying, either individually or in small groups" (Millar, 2004). As per ScoRE (2013), practical work in scientific education involves students observing, investigating, and developing an understanding of the world around them by direct experience of phenomena, which is often hands-on.

Practical work is considered an important part of science teaching as science itself is an empirical undertaking (Abrahams 2005; Hofstein and Mamlok-Naaman 2007; Ian and Reiss 2012; Millar 2010). From a pedagogical point of view, practical work in secondary education should enable students to connect the manipulation of materials and the observations they make to the scientific ideas intended in the curriculum, but it is precisely this step from hands-on to minds-on that is hard to accomplish (Abrahams and Millar 2008; Hodson 2014; Osborne 2015, 2019; Tobin 1990; White 1996).

Knowledge of cognition is what someone knows about their cognition in general (Schraw, 1998) and the possibility of implementing strategies (Garrison, 2003). Knowledge of cognition also determines the ability to become an independent learner (Duffy, Miller, Parsons, & Meloth, 2009). Knowledge of cognition includes knowledge used in approaching the questions 'what', 'how', 'when', and 'why' (Ma & Baranovich, 2015). Knowledge of cognition contains at least three aspects of cognitive awareness: declarative knowledge, procedural knowledge, and conditional knowledge (Schraw, 1998). Declarative knowledge is concerned with the insights of a person about their processing ability and the factors that affect their performance (Backer, Keer, & Valcke, 2011). Procedural knowledge is the knowledge about successful methods used to achieve specific learning goals and an awareness of how specific cognitive skills are applied in learning (Backer et al., 2011). Conditional knowledge emphasizes knowledge which connects facts, so that it is a form of inductive reasoning, that is, making a decision based on facts collected together (Kiesewetter et al., 2016).

Numerous studies demonstrate that practical activity gives students the chance to comprehend and manipulate science's abstract and complicated character, which effectively induces conceptual transformation (Daramola, 1987). Students' misconceptions are identified and corrected with the use of practical activity. Because of this, students become more receptive to verifying and gaining fresh perspectives on scientific information through practical activity. In order to help teachers complete this essential task, issues pertaining to their application of these tactics must be addressed using school-wide approaches.

High levels of conditional knowledge compared with the other types of knowledge are commonly found, for example, in the implementation of learning models such as modified project-based learning (Gassner, 2009). Conditional knowledge is also more stimulated than the other knowledge types.

Since 2005, the study's researcher has been employed as a physics instructor at Gilgel Beles College of Teacher Education (GBCTE). Although just a small percentage of students have performed well in physics, every year the results have been disappointing. Exam questions that test students' conceptual comprehension only made a minority of active students successful, while the majority failed. As a result, the researcher believes that secondary schools do not employ practical practice in physics education.

1.2. Statement of the Problem

Work experience in science education settings that provide students with chances to rehearse doing research (Stoffels, 2005). Corresponding to this, it is suggested that practical work would comprise opportunities for learners to practice and develop a variety of process skills, such as observing, interpreting, predicting, problem solving, communicating, and formulating and assessing conclusions (DBE, 2011a).

Researchers like Halai (2008), Kasanda (2008), and Ranade (2008) have discovered that low-quality science education is widespread in many developing nations; additionally, very few students study science at the secondary level and even fewer pursue science at the tertiary level in many of these nations. Ranade (2008); BANBEIS (2007). While diverse studies have yielded differing explanations for science students' inadequate content knowledge in developing nations, scholars like Cook and Taylor (1994), Thair and Treagust (1999), Millar and Abrahams (2009), Asikainen and Hirvonen (2010), have contended that a significant contributing factor is the absence of practical experience. According to research done in Ethiopia, secondary students do not have the hands-on learning opportunities outlined in the official scientific curriculum (Samuel Bekalo & Geoff Welford, 2010).

Sections of the scientific community and science educators themselves have expressed similar concerns, claiming that the amount and quality of practical work being done in schools is unequal and that there is not enough of it done in and out of the classroom. Secondary schools in the Metekel zone likewise reflect this. The way those actions are carried out could be impacted by certain elements. However, to the best of the researcher's knowledge, no research has been done to examine teachers' explicit understanding and capacity for carrying out their practical work, at least not in the study area or generally in the region. This highlights the need for study in this area to address the practices, challenges, and knowledge that teachers and students have when it comes to practical work in physics education.

Thus, in this study, the researcher looked at the knowledge, practice, and challenges that teachers and students face when teaching physics in the real world, especially at the Pawi K2V2 and Gilgel Beles Secondary schools in Benishangul Gumuz Regional State (BGRS).

Based on this aim in mind, the following basic questions were answered in this research.

1.What level of knowledge do high school physics teachers have about physics practical work?

2.What are the levels of practices of physics practical work in secondary schools?

3.What impede teachers' implementation of physics practical work in secondary school classroom?

1.3. Objectives of the Study

The main objective of this research was to study teachers' knowledge, practices of physics practical work instructions and challenges in teachers' use of practical work in their classroom.

Specifically, the objectives were:

1.To investigate level of knowledge of physics practical work amongst physics teachers in pawi K2V2 and Gigel Beles Secondary Schools.

2.To access the level of practices of physics practical work in these schools.

3.To identify factors that inhibits the implementation of practical work in physics teaching.

1.4. Significance of the Study

When a teacher steps into a science classroom, s/he faces usually many challenges in connection with subject delivery. The teacher encountered students from different backgrounds and experiences. The present study then might contribute to the following.

1.It might indicate major challenges in implementing of practical work in teaching physics.

2.It might emphasize and promote the importance of introducing practical work in physics classrooms.

3.It might be useful in providing ways of practicing practical work in learning physics.

4.It might provide insight for policy makers and developers how to monitor the regular implementation of physics practical activities in schools as planned by the curriculum.

5.It might inspire teachers and schools to carry out physics practical activities as designed by the curriculum or syllabus in a sufficient way to produce well qualified science graduates.

6.It might also be used as basis for further research in this area.

1.5. Scope of the Study

This study was delimited in searching for level of practices and challenges of physics practical work that teachers encountered at Pawi K2V2 and Gilgel Beles secondary schools. It also investigated the level of knowledge of cognition (declarative, procedural and conditional knowledge) of physics teachers in those schools.

Although the concept of practical work is so broad, this study was delimited in practical work related to teaching and learning physics in school level.

1.6. Limitation of the study

It would have been better if this study included representatives of all BGRS Secondary School science teachers. Due to the shortage of time, budget and resources, it was limited to physics teachers in those two secondary schools. Furthermore, physics practical work was an internal dialogue. This might also limit what the researcher wanted to know about physics practical work knowledge of the participants. In addition, when the questionnaire was administered, teachers participated in this study complained at that they didn't implementing physics practical work and unable to complete it. Then the researcher presented them with an overview of practical work. Some respondents didn't answer open ended questions as they didn't know what it means. All these might have affected the outcome of this research.

2. Research methodology

2.1. Research Design

The design of the research was a survey type. There were many governmental secondary schools in Metekel zone. Because of their proximity, the research was conducted in collaboration with students, teachers and principals working in Pawi K2V2and Gilgel Beles secondary schools. Students were required as they gave information what teachers were really practicing in classrooms. The principals also provided some challenges in the school context and also commented on the teaching practices of the teachers. The study examined what can be inferred regarding teachers' pedagogical understandings and practices of physics practical instruction. In addition, it closely looked at the factors affecting teachers' use of physics practical work in classroom practice.

2.2. Subject of the Study

We know that the sample of the study were representative of the population of the study. The subjects of the study were students (grades 9 and 10), physics teachers and principals of Pawi k2v2 and GilgelBeles secondary school in the academic year of 2022/2023. All physics teachers were taken from both schools. On this regard, there were 2 and 3 physics teachers in Pawi k2v2 and GilgelBeles secondary school respectively. In addition, there were total populations of 418 grade 9 students (173 and 245 students in Pawi k2v2 and GilgelBeles secondary school respectively) and 288 grade 10 students (135 and 153 students in Pawi k2v2 and GilgelBeles secondary school respectively) in the schools. By using probability proportional to size (pps) sampling method, the sample of students from each school was calculated as follow:

Let N be the total population of students and n the sample size: N=418(grade 9) +288(grade 10) $\Rightarrow$ N = 706

Then applying pps, the sample size n is given by: $n = \frac{N}{1+N(0.05)^2} = \frac{706}{1+706x(0.05)^2}$

$\Rightarrow$ n = 255 (Total sample of students)

Now, let n_{G9-P} be number of grade 9 students in the sample in Pawi k2v2 SS.

n_{G9-G} be number of grade 9 students in the sample in Gilgel Beles SS.

n_{G10-P} be number of grade 10 students in the sample in Pawi k2v2 SS.

n_{G10-G} be number of grade 10 students in the sample in Gilgel Beles SS.

Then the numbers of students in the sample from both schools were obtained as:

$$n_{G9-P} = \frac{\text{total no. of grade 9 students in Pawi k2v2 SS}}{\text{Total population}} xn = \frac{173}{706} x255$$
$$\Rightarrow n_{G9-P} = 62$$

$$n_{G9-G} = \frac{\text{total no. of grade 9 students in Gilgel Beles SS}}{\text{Total population}} xn = \frac{245}{706} x255$$
$$\Rightarrow n_{G9-G} = 89$$

$$n_{G10-P} = \frac{\text{total no. of grade 10 students in Pawi k2v2SS.}}{\text{Total population}} xn = \frac{135}{706} x255$$
$$\Rightarrow n_{G10-P} = 49$$

$$n_{G10-G} = \frac{\text{total no. of grade 10 Gilgel Beles SS}}{\text{Total population}} xn = \frac{153}{706} x255 \Rightarrow n_{G10-G} = 55$$

Adding all these, the total sample of students were 255. After the sample sizes of students were known from both schools, they were selected for the study by systematic sampling technique (selecting top eight students according to their rank from grades 9 and 10). Generally, including 4 principals of both schools (two from each), the total sample size was 264 (255 students, 5 physics teachers and 4 principals).

Table 1. Sample sizes of the study populations

Group of Population	Pawi k2V2SS.		Gilgel Beles SS		Calculated sample size
	Total population	Calculated sample	Total population	Calculated sample	
Grade 9	173	62	245	89	151
Grade 10	135	49	153	55	104
Physics teachers	2	2(all taken)	3	3(all taken)	5
Principals	2	2(all taken)	2	2(all taken)	4
Total sample size=264					

2.3. Data Collection Instruments

In the present study, questionnaire and interview were used as instruments of data collection. Thus, interview responses, answers to the written questionnaire.

2.3.1. Questionnaire

Three different questionnaires were used in this research. The first was administered to physics teachers while the 2nd and the 3rd were used for school principals and students in Pawi K2V2 and GBSS secondary schools.

2.3.1.1. Teacher questionnaire

The teacher questionnaire for this study was composed of the 1st component of PWI with 17 items and 5 open ended questions. They were used in this study because the PWI questionnaire and open-ended questions were used for similar study in previous researches.

The closed-ended questions focused on teachers' knowledge of cognition whereas the open-ended questions focused on teachers' physics practical work knowledge and strategy implementation. The opinions had to do with their general impression on knowledge of cognition regarding physics practical work knowledge, classroom implementation and its possible benefits to learning.

Teachers' responses to the open-ended part of the questionnaire indicated their knowledge of cognition and whether or not the information that they provided to the closed ended section were really true or not. The data gathered provided information that was useful in understanding the teachers' physics practical work knowledge and strategies. The questionnaire was administered to 5 physics teachers teaching in Pawi K2V2 and GB SS (2 and 3 respectively).

2.3.1.2. Pilot Study

According to Mugenda and Mugenda (2003), it is necessary to pilot-test the instruments to ensure that the items are clearly stated and can be understood by the respondents. The main purpose of the piloting was to determine validity and reliability of the research instruments.

Table 2.Reability statistics among items of each components of PWI questionnaire

Knowledge of cognition	Overall Cronbach's alpha	Number of items
Declarative Knowledge	0.946	8
Procedural Knowledge	0.937	4
Conditional Knowledge	0.921	5
		Total=17

The internal consistency was found to be 0.946, 0.937 and 0.921 among the items of declarative, procedural and conditional knowledge of physics practical work respectively (Table 2). Thus, PWI was reliable instrument to be used in this research.

2.2.1.3. Student questionnaire

Student questionnaire was also developed in this study. The questionnaire had two parts. The 1st part contained 17 items on a five -point rating scale ranging from 1 (Never) to 5(Always). Its aim was to study whether physics teachers were implementing practical work in physics teaching or not. The 2nd part with 12 items also had a five -point rating scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) regarding challenges (factors) that limit physics teachers from implementing practical work in class room.

In both cases students were provided with explanations about physics practical work by the researcher. In this way, the questionnaire was administered to 151 grade 9 students (62 and 89 from Pawi K2V2 and GB SS respectively) and 104 grade 10 students (49 and 55 from Pawi K2V2 and GB SS respectively).

2.3.1.4. School principal's questionnaire

There are two principals (one director and one vice directors) at each secondary school. In this study, the questionnaire for school principals was developed for the same purpose as that of the students. It had the same structure too except that the 1st part of this questionnaire had 21 items. It was administered to 4 principals (2 from each school). Both students' and principals' questionnaires were carefully developed.

2.3.2. Teacher interview

It provided teachers with the opportunity to express their views precisely on challenges of implementing practical work in physics teaching. The researcher had face-to-face interviews with the teachers. Three teachers took part in the interviews and were interviewed individually. All data in the form of interview transcripts were carefully read again and again to develop an understanding of the case.

2.4. Methods of Data Analysis

The purpose of this research was to study about teachers' level of physics practical work knowledge, practices of practical teaching and challenges of implementing practical work in physics teaching at Pawik2v2 and GBSS secondary schools.

Research question 1: What level of knowledge do high school physics teachers have about physics practical work?

Teachers' responses to the 17 items questionnaire on PWIA and to the 5 items open ended questions were used to answer research question one. Regarding the closed ended items, the total PWI scores for each of the three components (declarative, procedural and conditional) were expressed in averages for the total score separately and discussed. But prior to that, the internal consistency among the items of each of the three components and the internal consistency of the entire inventory were calculated step by step using Cronbach's alpha analysis. The analysis focused primarily on the written responses to the open-ended items using percentage analysis for each of the 5 items. This was because the written statements by the teachers on the open-ended items resulted in a better understanding of their general impressions on knowledge of cognition. Finally, both results were discussed in combination and the answer to the question was reached.

Research question 2: What are the levels of practices of physics practical work in these schools?

Research question 2 was answered using the data from responses of students and principals to the 1st part of their respective questionnaire. Students' responses were described using percentage analysis for grades 9 and 10 separately. The procedures were repeated for principals. The Mann-Whitney U test was used to investigate whether there was significant difference between grades 9 and 10 responses to reach on the conclusion for this particular question.

Research question 3: What impedes teachers' implementation of physics practical work in secondary school classroom?

Students' and principals' responses to the 2nd part of their respective questionnaire and teachers' interview responses were used to answer the last question of this research. Since parts of the questionnaires concerning challenges of physics practical teaching were identical for students (grades 9 and 10) and principals, they were analyzed for significant differences in their responses using ANOVA test after each of them were separately analyzed using percentage frequency of occurrences. Students' and principals' responses to the open-ended questionnaire, and teachers' interview responses were used to supplement the results of the data obtained through the closed ended questionnaire.

Finally, the data from questionnaire and interview were organized, coded into SPSS and analyzed. Based on the analysis of data, the results were discussed and summarized to give conclusion and recommendation.

3.Results and discussion

The data collected through interviews and the questionnaire were divided into several sections for analysis using the techniques outlined in the methodology section. There were discussions and interpretations after each analysis. In the end, findings derived from the data for every research topic were delivered along with recommendations.

3.1. The level of knowledge of teachers in physics practical work

This section included a discussion and display of the teachers' questionnaire results. It was divided into two parts. First segment PWI scores for the three components (conditional, procedural, and declarative). Each concern expressed as a percentage and had individual discussions about it. PWI was used in this study because it contains a greater number of components that are representative of actual work practices. The second section included the written responses from the teachers regarding their general views on cognition knowledge in response to the five open-ended questions.

Teachers' questionnaire

a)The closed ended PWI (part I)

Table 3.Average scores of teachers (n=5) on PWI questionnaire

TI→	1	2	3	4	5	Average
DK	3.38	4.38	4.38	3.63	2.75	3.7
PK	3	4.75	4	3.25	2	3.4
CK	3.2	4.6	4.6	3.8	2.8	3.80
Overall average						3.63

Note: TI- Teachers' ID.

2.00* indicated low level of procedural knowledge.

In terms of declarative knowledge (DK), procedural knowledge (PK), and conditional knowledge (CK), teachers' PWI average scores range from 2.75 to 4.38, 2.00 to 4.75, and 2.80 to 4.60, respectively.

A person with a PWI score of fewer than 2.5 average points had poor practical work awareness, whereas a person with a score of more than 2.5 average points had strong practical work awareness. Based on the available data, it appears that 100% of the teachers who took part in the study had higher levels of declarative and conditional knowledge, while 80% of teachers (4 out of 5) had higher levels of procedural knowledge. Table 3 shows that around 20% of the teachers, or 1 out of 5, had low procedural knowledge (average score = 2.00). The teachers' overall average scores on the knowledge of cognition generally fall between 2.00 and 4.75.In summary, a grand average score of 3.60 on PWI suggested that around 93.3% [100+100+80)/3] of the teachers possessed a higher degree of declarative, procedural, and conditional knowledge. It was evident that the teachers had a better level of knowledge cognition because their overall PWI score (3.60) was higher than 2.50. However, as procedural knowledge pertains to the specifics of how cognitive functions are carried out, it may be significant to highlight that teachers' overall practical knowledge appears to be impacted by their inadequate procedural knowledge.

b) The open ended (part II)

The open-ended questionnaire responses from teachers were analyzed in relation to their cognitive knowledge in this section. The responses were given for each item as shown in table 4 below.

Table 4. Teachers' responses to the open ended questions regarding their PWK

Item	Type (level) of responses	f	p
1	No response	1	20
	Poor	1	20
	To some extent	1	20
	Good	2	40
Total	5		
2	No response	1	20
	Listed the types but wrongly explained them	2	40
	Listed the type and explained them well	2	40
Total	5		
3	No response	1	20
	Poor	2	40
	To some extent	1	20
	Good	1	20
Total	5		
4	No response	1	20
	Unrelated	2	40
	To some extent	2	40
Total	5		
5	No response	1	20
	Poor	1	20
	To some extent	2	40
	Mentioned that he didn't know how	1	20
Total	5		

Note:f=frequency,p=percentage

Item 1: What is practical work?

Of the responded teachers, 20% of them had no response while 20% of them gave poor definition to practical work (Table 4). Those who tried the definition to some extent were 20%. On the other hand, another 40% of the teachers known the definition of practical work. From this result, it could be said that about 40% (20%+20%) of the teachers had no clear idea what was meant by practical work.

Item2: What are the types of physics practical work? Explain each of them.

Here again, 20% of the teachers had no response while 40% of them were found on a poor level of knowledge regarding the types of practical work. From the same table, it was also seen that 40 % of the teachers know the types of practical work and explained well. This study showed that only 40% of the teachers had good level of knowledge about the types of practical work while 60% of them were unable to list and explain the types of practical work clearly (Table 4).

Item3: How do you apply practical work to your actual classroom during physics teaching? Briefly elaborate with example(s).

At most, about 20% of the teachers had good level of knowledge about classroom applications of practical work while 20% of them had knowledge of applying practical work to some extent (Table 4). The rest 60% were either had no response, were with poor level of knowledge about the classroom application of practical work or were not in position to differentiate practical work from others. Hence, it can be said that 60% of the teachers didn't know how to apply practical work in physics teaching. Totally, 60 %(20%+40%)

of them didn't elaborate on their methods how they used practical work in their classrooms.

Item4: What are the important roles of the teacher in developing motivation of students' practical work in physics teaching?

Teachers who know their roles to some extent in developing students' motivation in practical work and those who had roles which were not related to developing students' motivation of practical work were 40% each. Again, 20% of them had no idea in developing students' motivation in practical work. Generally, it appeared that none of the teachers were having good level of knowledge about their roles in developing students' motivation in practical work (Table 4).

Item5: How do practical works help students to be successful in physics learning?

It seemed that 20% of the teachers didn't know how practical work help students to be successful in learning while the knowledge of 20% of the teachers was found to be poor on the same concept. Only 40% of them knew to some extent how practical work contributes to students' success. Overall, none of the teachers had good level of knowledge how practical work contributes to students' success.

Generally, it appeared that the results of Table 4 challenged results of Table 3 showing that the teachers' level of knowledge about knowledge of cognition was poor or absent for most of them. This result agreed with what the researcher of this study faced during data collection from teachers. Some of the teachers complained that they didn't know practical work through practice. Another cause of the contradiction might be, not knowing the practical work, the teachers responded to the PWI only for the sake of getting high scores or it might be their negligence response to the PWI part.

3.2. The Level of Practices of physics practical work by Secondary School Teachers

In this section, students' and principals' questionnaire were analyzed to answer research question 2.

a) Students' questionnaire (part I)

To evaluate the extent to which secondary school physics teachers (in Pawi K2V2 and GB SS) were applying physics practical work strategies in their classrooms, the data were also collected from students of grades 9 and 10.

As provided in appendix I, the items were about physics practical work strategies through verbalization(items 1 to 4), small group work (items 5 to 10), prompting questions (items 11 to 14), scaffolding and graphic organizers (15 to 17).

Taking the sum of the averages for each item group in appendix Table 4 for grade 9 and appendix Table 6 for grade 10, the results were summarized in Table 5 as follow.

Table 5. Students' responses to level of physics practical work teaching (LPWT)

Item Groups	Respondent Groups			
	Grade-9		Grade-10	
	Never/Seldom	often/always	Never/Seldom	often/always
Verbalization	41.7	31.8	50.0	27.9
Small Group	60.3	19.2	71.2	17.3
Prompting	43.7	31.8	51.9	26.9
Scaffolding	39.1	35.8	50.0	25.0

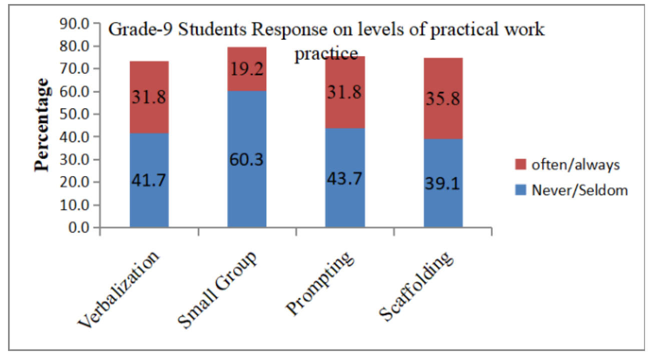

Figure 1: Grade 9 students' responses to level of physics practical work teaching

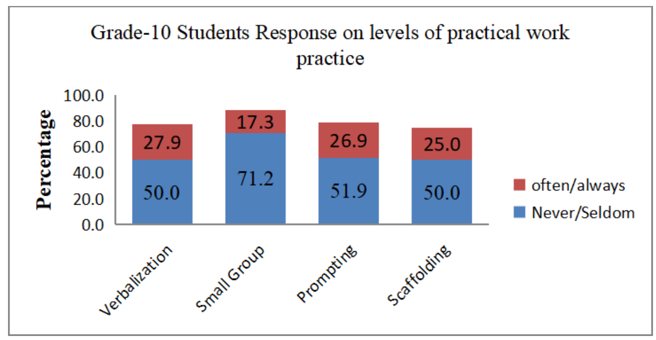

Figure 2: Grade 10 students' responses to level of physics practical work teaching

For items 1 to 4, 41.7 % of grade 9 students and 50% of grade 10 students responded that their physics teachers never or seldom used physics practical work through verbalization while 31.8% and 27.9%(respectively) of them confirmed that their teachers used the same method often or always. Thus, it seemed that the level of practices of physics practical work through verbalization was low (Table 5).

Again for items 5 to 10 (Table 5), 60.3 % of grade 9 students and 71.2% of grade 10 students confirmed that their physics teachers never used physics practical work through small group work. On the other hand, 19.2% students from grade 9 and 17.3% from grade reported that the teachers used this method frequently. Hence, this result might indicate that 60.3% or more students participated in the study didn't learn through small group practical.

As far as items 11 to 14 were concerned, about 43.7 % of grade 9 and 51.9% of grade 10 students' idea was that their physics teachers never or seldom used prompting questions, while 31.8% from grade 9 and 26.9% from grade 10 said that their physics teacher used the strategies often or always. As these prompting strategies (practical) were required in most of the topics in physics, high school physics teachers used it not to the desired level.

Referring to the same table (Table 5), only 35.8% and 25% (from grades 9 and 10 respectively) of students learned through scaffolding and graphic organizers frequently while 39.1% and 50% (from grades 9 and 10 respectively) of the students learned never or seldom through this method.

From these results, it might be said that most of the secondary school physics teachers (in Pawi K2V2 and GBSS) didn't use practical work in their classrooms in physics teaching. Based upon percentage analysis discussed above, the opinions of grades 9 and 10 students about the level of teachers practical work teaching was similar that in both cases the result showed that the levels were very low.

Furthermore, the responses given by grades 9 and 10 regarding the level of practices of practical work teaching in physics by physics teachers were tested using the non-parametric Mann-Whitney U test for significance difference for each group of the items and the results were presented in the following table (Table 6).

Table 6. Mann-Whitney U test between grades 9 and 10 students for ‘never/seldom’ response.

Item group	Verbalization	Small group work	Prompting	Scaffolding
Asymp.Sig. (2-tailed)	0.317	0.317	0.317	0.317

* Not significant at p = 0.05(table 6).

This test was repeated to know if any significant difference existed between grades 9 and 10 students on their response to ‘often/always’ category. Identical result to Table 6 above was obtained. Hence, there were no significant differences between responses of grades 9 and 10 students regarding LPWT. This might indicate that teachers’ level of practical implementation was low whether the responses were given by grade 9 or grade 10 students (see figure 3&4).

b) Principals’ questionnaire (part I)

The purpose of this questionnaire was to collect data from principals regarding LPWT by physics teachers in Pawi K2V2 and GB secondary schools. In this way, the data obtained from their responses were expressed in percentages (Table 7).

The items in the questioner may be divided into the following catagories Items: 1-4: Reflective questions and prompts, 5-8: small group work, 9-12: mastery questions, 13-18: scaffolding, modeling and self questioning, 19-21: think aloud.

Table 7. Principals’ responses to the LPWT by physics teachers

Respondent	Scale	Item groups: Reflective questions and prompts	Small group work	Mastery questions	Scaffolding, modeling and self-questioning	Think aloud
Principals	Never/ seldom	15.63%	50.48%	43.73%	43.73%	33.4%
	Often/ always	25.04%	31.23%	21.93%	21.93%	33.27%

About 15.63% (Table 7) of the school principals said that grades 9 and 10 physics teachers in their schools never or seldom used reflective questions and prompts. About 25.04% of the principals observed that the teachers used this method often or always while the rest 59.43% responded that the teachers used these method some times. Hence, majority of the principals reported that the teachers used the reflective questions and prompts sometimes only.

Referring to the same table, it might be said that the number of principals (50.48%) who observed that grades 9 and 10 physics teachers in their schools never or seldom used practical work through small group work were greater than (31.23%) those who observed that the teachers used the method often or always.

Regarding mastery questions, scaffolding, modeling and self questioning strategies, and 43.73% of the principals said that physics teachers in their schools never or seldom used those methods while those who said that the teachers used these methods were 21.93%. On comparison, more principals observed that physics teachers in their schools never or seldom used mastery questions, scaffolding and think aloud strategies in their classrooms. In all cases, the majority of the principals reported that grades 9 and 10 physics teachers in their schools never or seldom used practical activities strategies in physics teaching.2.3. Data Collection Instruments

In the present study, questionnaire and interview were used as instruments of data collection. Thus, interview responses, answers to the written questionnaire.

3.3. Challenges of implementing practical activities in Physics Teaching

Based on information from teachers' interviews, principals' questionnaires, and student surveys, the difficulties of integrating practical practice into physics instruction were examined. In this section, the following items were taken into consideration (used in Table 8):

1.Insufficient time for teaching.
2.Large class size.
3.Lack of well-equipped laboratories.
4.Overloaded curriculum.
5.Inadequate teacher motivation.
6.Students have no such learning experiences before.
7.The nature of the subject didn’t allow the teacher to use practical Activities.
8.Lack of professional development for teachers.
9.The teacher didn’t believe that practical work help students’ learning.
10.The teacher didn’t know how to integrate practical work in his/her classroom teaching.
11.Lack of laboratory technician.
12.The teacher didn’t have enough knowledge regarding practical work.

a) Students’ and principals’ questionnaire (part II)

This part of the questionnaire was about challenges that limit implementations of practical work in physics teaching. The responses were displayed in Table 8.

Table 8. Analysis of responses of students and principals to CPW

No	Items	G9 sd/d	G9 sa/a	G10 sd/d	G10 sa/a	Pr sd/d	Pr sa/a
1	Insufficient time for teaching.	43	37.1	54	33	0	50
2	Large class size.	53	26.5	61	22	25	75
3	Lack of well-equipped laboratories.	46.4	19.9	54	24	0	75
4	Overloaded curriculum.	41.7	21.2	52	32	25	75
5	Inadequate teacher motivation.	36.4	20.5	68	21	0	50
6	Students have no such learning experiences before.	49.7	29.1	43	30	25	75
7	The nature of the subject didn’t allow the teacher to use practical work	74.2	20.5	55	20	0	75
8	Lack of professional development for teachers.	60.3	20.8	34	63	25	75
9	The teacher didn’t believe that practical work help students’ learning.	50.3	29.8	52	22	25	75
10	The teacher didn’t know how to integrate practical work in his/her classroom teaching.	53.6	21.2	38	52	25	50
11	Lack of laboratory technician.	52.3	24.5	36	55	75	0
12	The teacher didn’t have enough knowledge regarding practical work.	60.9	20.5	53	28	50	0

The numbers in the above table are in percentages.

sd/d= strongly disagree or disagree, sa/a= strongly agree or agree

G-9 = grade 9, G -10 = grade 10, Pr = principals

Most grade 9 students who responded disagreed or strongly disagreed that the following variables impacted or posed challenges for the implementation of practical practice in physics education: Lack of well-equipped laboratories, huge class sizes, inadequate teacher motivation, and an overburdened curriculum Such learning opportunities are new to the students, the subject's nature Absence of teacher professional development There was a lack of laboratory technicians, the instructor didn't think that practical work aided students' learning, and the teacher didn't know how to include practical work into their classroom instruction. However, due to the overabundance of physics curriculum, 37.1% of the students agreed or strongly agreed that there was not enough time for practical work to be used in physics education.

Students in grades 10 were more likely than those in grades 9 to disagree or strongly disagree that the reasons cited challenged the teaching of practical work. The majority of grade 10 students also agreed or strongly agreed that there was a lack of laboratory technicians, a teacher's inability to include practical work into their lesson plans, and a lack of professional development opportunities for teachers.

Most school principals agreed or strongly agreed that the following factors had an impact on how practical work was implemented: the length of time required for practical work, the size of the class, insufficiently equipped laboratories overly demanding curriculum insufficient drive among teachers, Such educational experiences are new to the students. The topic's nature, teachers' lack of professional development, their belief that hands-on experience enhances pupils' learning, there was a shortage of laboratory technicians and the teacher was unsure of how to incorporate practical work into their lessons. Regarding points 11 and 12, however, the principles disagreed or disagreed severely.

Lastly, one way ANOVA was used to examine the replies from three respondents (principals, grades 9 and 10) to see if there were any noteworthy variations in their.

Table 9.Results of ANOVA test regarding CPW

	Sum of squares	df	Mean square	F	Sig.
Between Groups	.557	2	.279	1.227	.295
Within Groups	58.157	256	.227		
Total	58.714	258			

Due to [F = 1.227)& p = 0.295], there was an insignificant difference in the three respondents' responses (Table 9) at the p = 0.05 level. The results of this test at α = 0.05 showed that while the principals' responses (M = 3.0425, SD =.34856) were marginally significant from the students' responses (Table 10), the mean responses of grade 9 students (M = 2.7086, SD =.44231) did not differ significantly from those of grade 10 students (M = 2.6728, SD =.52553).

Table 10.Descriptive of ANOVA test at 95% confidence interval around the mean

	N	Mean	Std. Deviation	Std. Error	95% confidence interval for mean Lower Bound	Upper Bound	Minimum	Maximum
Grade 9	151	2.7086	.44231	.03599	2.6375	2.7797	1.58	3.58
Grade 10	104	2.6728	.52553	.05153	2.5706	2.7750	1.58	4.08
Principals	4	3.0425	.34856	.17428	2.4879	3.5971	2.67	3.50
Total	259	2.6994	.47705	.02964	2.6410	2.7578	1.58	4.08

This test revealed a significant difference between the respondents' responses, but it did not specify the exact location of the discrepancy. Therefore, the contrast test was used to pinpoint the location of the response difference.

The contrast coefficients in the one-way ANOVA window were input so that the total of the coefficients for a single row was zero. The researcher chose 1, - 1 and 0 for this test based on this approach.

Table 11.Contrast coefficients

Contrast	Group		
	Grade 9	Grade 10	Principals
1	1	0	-1
2	0	-1	1
3	1	-1	0

Contrasts 1 and 2 respectively compared responses of grades 9 and 10 students with that of the principals while the last contrast compared responses of grades 9 and 10 students to each other. The results were given in Table 12 below. Contrast 1and 2 from Table 12 compared responses of grades 9 and 10 students. This showed that the responses were insignificant (p = 0.168) while that of the principals was significant from both groups of students as indicated (p = 0.000) by contrasts 1 and 2. Again it was noted that whether equal variances were assumed or not, there was no significant difference between responses of grades 9 and 10 students (Table 12).

Table 12.. Contrast Tests

	Contrast		Value of contrast	St. Error	t	df	Sig. (2-tailed)
Response	Assume equal variances	1	-.3339	.24145	-1.383	256	.168
		2	-.3339	.24145	-1.383	256	.168
		3	17.1817a	.72207	23.795	256	.000*
	Doesn't assume equal variances	1	-.3339	.17796	-1.876	3.261	.150
		2	-.3339	.17796	-1.876	3.261	.150
		3	17.1817a	.53411	32.169	3.267	.000*

*Significant difference exists at 0.05.

The difference in responses of students and principals might be due to the difference in their levels of practical work (perception about practical work). It appeared that principals were at a higher level of practical work than students of grades 9 and 10 in responding to challenges of practical work teaching at secondary schools. Hence, the difference in the level of practical work led to different responses regarding CPW. Comparatively, when respondents of higher level of practical work comment on the CPW, the challenges were mainly found to be: practical work need large amount of time, the large class size, teachers' professional development and teachers had no enough knowledge about the practical work and didn't believe that practical work help students.

b) Teachers' interview

In this study, teachers were interviewed regarding CPW. The researcher carefully examined each interview to identify the described factors (challenges) that influenced practical work. The most frequently mentioned factors by physics teachers in Pawi K2V2 and GBSS that limit practical work were: lack of laboratory equipment, students' low attitude towards physics, the large class size, the strategies take large amount of time, the teachers were not well trained in practical work instruction and didn't know much about it and students' poor background on physics. It was noted that these responses were similar to the responses given by school principals discussed in Tables 8.

3.4. Summary of major challenges of physics practical work

a) From students' responses

The majority of students stated that the practical work in physics was difficult because: they had not previously encountered such learning opportunities; teachers' practices of imparting knowledge without difficulty or skill; teachers' inappropriate use of time; some teachers were not suited for teaching; some teachers didn't enjoy teaching and didn't care how to use the practical work; most teachers became teachers because the government assigned them to do so; and teachers lacked the necessary skills to impart their knowledge to students.

b) From principals' responses

According to principals, physics practical work was difficult in their school because:

There is insufficient amount of time, the large class size, lack of laboratory equipment, lack of teachers' professional development and teachers didn't believe that the practical work help students, teachers' lack of detail knowledge in practical work, problem of subject matter knowledge, lack of skilled teachers in practical work.

c) From teachers responses

The major obstacles to practical work instruction, according to the teachers involved in this study, were students' poor physics background, large class sizes, lack of laboratory equipment, teachers' lack of training in practical work instruction, and students' negative attitudes toward physics.

It was observed that the explanations given by principals and teachers for the difficulties encountered in the study area's practical work were quite similar. Overall, the three groups of respondents concurred that the lack of prior experience for learners and the teachers' inadequate understanding of practical work made it challenging to apply the practice.

4. Summary, conclusions and recommendation

4.1. Summary

The purpose of this study was to investigate the practical work practices, obstacles to adopting physics practical work in the classroom, and teachers' level of understanding regarding physics practical work. Three groups of people were taken into consideration in this study: physics teachers, Pawi K2V2 and GB secondary school principals, and students in grades 9 and 10. 151 samples from grade 9 and 104 samples from grade 10 students that were chosen through systematic sampling were taken into consideration using the PPS sampling method. The sample size was 264 in total (255 students, 4 principals, and 5 teachers), taking into account all of the principals and physics teachers from both schools.

Data collection tools included questionnaires and interviews. Using the percentage frequency on PWIA for knowledge of cognition, the teachers' questionnaire data was examined. In contrast to the open ended result, which indicated that most teachers had little to no knowledge of practical work, the PWIA analysis result revealed that around 93.3% of teachers had declarative, procedural, and conditional knowledge. The percentage analyses of the LPWT questionnaire completed by principals and teachers indicated that physics teachers were not implementing a high enough level of specific practical activity in their physics classes. The Mann-Whitney U test was utilized to examine student responses for statistically significant differences in this regard. No discernible variations were seen in the responses between students in grades 9 and 10.

An ANOVA test was utilized to assess the replies from principals and students regarding CPW. The results of the contrast test revealed that while there was no significant difference between students in grades 9 and 10 on CPW at $p = 0.05$ ($p = 0.160$), there was a significant difference between the principals' responses at $p = 0.05$ from students' responses ($p = 0.000$). According to percentage study, physics teachers' LPWT was found to be low by principals and students alike. The findings of the open-ended questionnaire and interview revealed that students with weak physics backgrounds and instructors with low levels of cognition knowledge were the main causes of CPW in Pawi K2V2 and GB secondary schools.

4.2. Conclusions

In science education, practical work provides students with opportunities to practice conducting investigations. Additionally, it is practical work that entails opportunities for learners to practice and improve a variety of process skills, such as hypothesizing, observation, interpreting, predicting, problem solving, communicating, and drawing and assessing findings.

This study was designed to answer three questions. Based on the findings discussed so far, the following answers were found.

According to the teachers' PWIA scores, teachers' declarative, procedural, and conditional knowledge was either nonexistent or at very low levels. The teachers were instinctively aware of the ideas behind the practical activity, but they were unaware of the operational definitions and other related concepts.

Based on the information gathered from questionnaires sent to students and principals, the majority of respondents stated that their school's physics teachers either never or very seldom used practical work. Therefore, such teachers' level of actual work experience was quite low (never or infrequently).

The following factors appeared in teacher interviews and student and principal questionnaire responses: these factors had an impact on how physics practical work was implemented. There is not enough time, there are too many students in each class, there is a shortage of professional development opportunities for teachers, and the teachers themselves lack sufficient knowledge of and belief in the value of the practical work for pupils. As can be seen from Table 12, when it came to reacting to the issues associated with implementing practical work in secondary schools, administrators had a higher level of experience than students in grades 9 and 10.

4.3. Recommendations

The need of analyzing teachers' knowledge of cognition who will educate future generations is very essential. Based upon this and the findings of the study, the researcher highlighted the following.

1.The future of practical work is not hopeful unless teachers receive formal training in practical work, as it was discovered that their level of cognition knowledge is low.

2.Teachers who took part in this survey reported that their university education had minimal effect on their ability to apply practical work in the classroom and gain new knowledge. Teachers thus require chances for professional development related to the application of actual work.

3.Secondary schools are intended to have access to laboratory equipment so that teachers can practice and expand their understanding of practical work.

4. The number of pupils in the class should be in line with secondary school standards, as high class sizes have an impact on how practical work is implemented.

5.Research is needed to determine what aspects of instruction will make practical work in secondary schools useful.

6.This study was the initial attempt to ascertain the practical work knowledge of physics teachers. To better understand how teachers and students manage their own teaching and learning activities, more research should be done in the area of practical work control.

References

Abraham I. and Millar R. (2008), Does practical work actually work? A study of the effectiveness of practical work as teaching method in School Science.

Abrahams, I. & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science, International Journal of Science Education, 30(14): 1945-1969.

Backer, L. De, Keer, H. Van, & Valcke, M. (2011). Exploring the potential impact of reciprocal peer tutoring on higher education students' metacognitive knowledge and regulation. Instructional Science, 40(3), 559–588.

Black, P. (1993). Challenges and opportunities in science education. London: Paul Chapman Publishing Limited.

Cook, A., & Taylor, N. (1994). Robust adaptive processes: The case for laboratory assistants in Fiji high schools. Journal of Science and Mathematics Education in South-east Asia, 17 (2), 7–15.

Cook, A., & Taylor, N. (1994). Robust adaptive processes: The case for laboratory assistants in Fiji high schools. Journal of Science and Mathematics Education in South-east Asia, 17 (2), 715.

Daramola S.O., (1987). Restructuring Science Education Programmes in Nigerian Higher Institutions, Journal
Duffy, G. G., Miller, S., Parsons, S., & Meloth, M. (2009). Teachers as metacognitive professionals. Handbook of Metacognition in Education, 240.
Garrison, D. R. (2003). Cognitive presence for effective asynchronous online learning: The role of reflective inquiry, self-direction and metacognition. The University of Calgary, 4, 47–58.
Gassner, L. (2009). Developing metacognitive awareness-a modified model of a PBL-tutorial. Malmo University.
Halai, N. (2008). Curriculum reform in science education in Pakistan. In R. K. Coll & N. Taylor (Eds.), Science Education in Context: An International Examination of the Influence of Context on Science Curricula Development and Implementation. (pp. 115-129).
Halai, N., (2008). Curriculum reform in science education in Pakistan. In R. K. Coll & N. HMI/Office for Standards in Education (Ofsted), (2004a). Science in Primary Schools.
Hofstein, A., Lunetta, V.N. (2003). The Laboratory in Science Education: Foundations for the TwentyFirst Century. Science Education. The Pennsylvania State University, University Park.
Kasanda, C. D., (2008). Improving science and mathematics teachers" subject knowledge in Namibia.
Kerr J.K (1963), Practical work in school science, England and Wales, Leicester University press.
Kiesewetter, J., Ebersbach, R., Tsalas, N., Holzer, M., Schmidmaier, R., & Fischer, M. R. (2016). Knowledge is not enough to solve the problems – The role of diagnostic knowledge in clinical reasoning activities. BMC Medical Education, 16(1), 303. https://doi.org/10.1186/s12909-016-0821-z
Kulik, J.A. (1992). An analysis of the research on ability grouping. Storrs: University of Connecticut.
Kunisch, S., Denyer, D., Bartunek, J., Menz, M., & Cardinal, L. B. (2022). Review Research as Scientific Inquiry. Organizational Research Methods, 26, 3-45.
Larcher, D., & Tarascon, J. (2015). Towards greener and more sustainable batteries for electrical energy storage. Nature chemistry, 7(1), 19-29.
Ma, A., & Baranovich, P. D. (2015). Promoting self-regulation in vocabulary learning among Chinese EFL learners : A needs analysis, 24(1), 137 – 146. https://doi.org/10.1007/s40299-013-0166-x
Millar, R. (2004). The role of practical work in the teaching and learning of science. High school science laboratories: Role and vision. National Academy of Sciences, Washington, DC. York: The University of York.
NTI (2007).Workshop on Difficult Concepts, Group Report. Nigerian Educational Research and Development Council, Lagos.
Ranade, M. (2008). Science education in India. In R. K. Coll & N. Taylor (eds), Science Education in Context: An International Examination of the Influence of Context on Science Curricula Development and implementation (pp. 99-114). Rotterdam: Sense Publishers.
Samuel, B. and Welflord, A.G. 2000. Practical activities in Ethiopian secondary physical sciences: Implications for policy and practice of the match between the intended and implemented curriculum. Research Papers in Education, 15,185-212.
Schraw, G. (1998). Promoting general metacognitive awareness. Instructional Science, 26(1–2), 113–125. https://doi.org/10.1023/A:1003044231033
Trivedi, R. and Sharma, P. (2013) A Study of Students' Attitude towards Physics Practical at Senior Secondary Level: International Journal of Scientific and Research Publications, 3(8).
Tsai, C. (2003). Taiwanese science students' and teachers' perceptions of laboratory learning environment: exploring epistemological gaps. International Journal of Science Education,25(7) :847-860.89.
Wellington, J. (1998). Practical Work in Science: Time for a Re-appraisal. Practical Work in School. In J. Wellington (Ed.), Practical Work in School: Which Way We Now? (pp.3-15). London and Newyork: Routledge.