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# Recent Reforms in Saudi Secondary Science Education: Teacher and Student Perceptions of Grade 10 Physics

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**Abstract** Recent research in science education for learners whose first language is Arabic suggests that learning in the mother tongue can reduce learner misconceptions, but there has been little research into the comprehensibility of science texts where Arabic is the language of instruction. This mixed-methods study describes the perceptions of substantial changes in science education, including translation of American science textbooks into Arabic, expressed by six grade 10 physics teachers and 360 grade 10 physics learners in two cities in Saudi Arabia. Factor analysis allowed themes emerging from the teacher interviews to be compared with underlying constructs from student questionnaire responses. Results reveal teachers' and students' concerns about adequacy of resourcing for the newly mandated student-centered style of learning, and language difficulties affecting comprehensibility of the textbook to support students' learning. These findings suggest that science education policymakers should consider all components of constructive alignment if they wish to achieve the goals of science education reform that they set for themselves.

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## Introduction

Recent years have seen huge efforts to overhaul education systems in Arab countries. Comprehensive knowledge-based reform programs are expected to develop a skilled workforce to accomplish national social and economic goals (Maroun, Samman, Moujaes, & Abouchakra, 2008), particularly in Saudi Arabia (Ministry of Education, 2006). One of the goals of secondary-level changes in the Saudi education system is to develop students' scientific thinking and deepen their motivation to engage in experimental research and consequently to improve their performance (Al-Ghamdi & Abdul-Gawed, 2010).

Textbooks are widely recognized as a major source for learners. Text is commonly used to convey scientific concepts, and the ability to comprehend textbooks can be crucial to learner understanding of school science (Norris & Phillips, 2003; Pearson, Moje, & Greenleaf, 2010). How teachers utilize such textbooks so that learners improve their scientific literacy is fundamental (Sørvik & Mork, 2015).

## Background to Saudi Science Education

The Saudi education system is centralized, and all the policy and decision-making is authorized by the Ministry of Education (MoE) who provide textbooks for free for both teachers and students (Al-Mazroa & Al-Shamrani, 2015; Al-Qarni, 2013). The school system is characterized by gender segregation (Rugh, 2002).

The dominance of the rote memorization style of teaching and learning has been identified as a fault in the Saudi education system. Consequently, ongoing reform has emphasized developing learner practical skills and implementing collaborative work (Courington & Zuabi, 2011). In 2003, the MoE announced a King Abdullah Bin Abdul-Aziz 10-year education project plan to operate between 2004 and 2014 (Ministry of Education, 2004), conducted by Tatweer Company for Education Services (Tatweer, 2010). This is one of the companies that belong to Tatweer Education Holding Company, owned fully by the Public Investment Fund of the Kingdom of Saudi Arabia, and concerned with the development of public education in its various aspects. This project consists of four axes all of which aim to integrate the educational process. These programs focus on curriculum affairs, teachers, classrooms, and non-curricula aspects, by developing and training teachers, creating better curricula and educational environments, and by focusing closely on learner skills outside the classroom (Tayan, 2017).

In focusing on developing curriculum at the secondary level the MoE stated its intention as "Improving Secondary Education and its branches, and providing students with the necessary skills" (Ministry of Education, 2004, p. 15). The changes in Saudi secondary schools are intended to overcome barriers whether in the area of school buildings, teachers' qualifications, or the rigidity of the curriculum and methods (Al-Sonbul, Al-Khateeb, Motwali, & Abdulgawad, 2008). The three grades of secondary schooling include discipline-based science courses: Physics, Chemistry, Biology, and Earth Science (Al-Dahmash, Mansour, Al-Shamrani, & Al-Mohi, 2016). Upon completion of grade 10, students are required to choose between scientific, art, or administrative tracks.

## Old and New Science Curriculum

A new textbook-based science curriculum was produced in collaboration with Obeikan Research Development, a private company currently implementing the largest educational K-12 development and educational reform program executed by a private sector organization in the Arab World to develop Islamic textbooks, mathematics, and natural sciences for Saudi Arabia, the Gulf States, and Yemen (Obeikan Education, 2013). This company contracted with the American publishing company McGraw-Hill to provide a translation of mathematics and science textbooks for grades K-12 (Al-Ghamdi & Al-Salouli, 2012; McGraw-Hill, , n.d.). These books were translated from the original language (English) and slightly adapted in line with the Saudi educational environment and Saudi culture (Al-Shamrani, 2012). As this work was commercially contracted, little detail has been made available about the processes and procedures used in the translation and adaptation. The Obeikan company website (in Arabic) says that their translators worked with educators to ensure quality of the translation.

Saudi teacher dissatisfaction with the existing physics textbook and the low education level of their students had prompted this almost direct transfer or science curricula and materials, which represents the first stage in the cross-national policy borrowing process described by Phillips and Ochs (2004). The Department of Curriculum in the Ministry of Education appears to have moved quickly to stage II, with textbook choice and translation resembling a "quick fix." This raises questions about the suitability of this text and the basis for its selection in relation to the curriculum, as well as whether the language in the translated physics textbook is suitable to the Saudi context. Such translated books might be missing some essential concepts, and the method presented to students to improve their critical thinking may be inappropriate for Saudi students (Cook & Robert, 2016). This paper will examine that question without proceeding to detailed treatment of further stages in the illuminative model provided by Phillips and Ochs.

Many teachers considered the previous science textbooks to be boring and monotonous, to lack information, and to focus on mathematics exercises that did not encourage student participation in experimental work. Rather, the pedagogy was teacher-centered and based on learner memorization (Al-Tawil, 2013).

Student-centered learning forms the basis of the new textbook, which supposedly allows students to engage with subject material directly rather than just memorizing it superficially. The new physics textbook and curriculum was first introduced for grade 10 in 2010 – 2011; some teacher participants in our study reported receiving training at the beginning of that year, while others reported no training. The first, trial edition, and teachers' guides were used in 2010 – 2011, a revised edition was issued for 2012 – 2013, and a final edition was issued in 2014 and is used up to the present date. The new science pedagogy reflected in the textbook is an application of the constructivist theory of knowledge and focused on problem solving and critical thinking (Al-Ghamdi & Al-Salouli, 2012; Al-Kahtani, 2015). However, there are doubts that this new reform could be fully successful, as the content and quality of the American textbook is based on a specific Western community, which might not match the needs of Saudi students (Boujaoude & Gholam, 2014). These commentators have suggested that development of a science curriculum should involve local science teachers to produce a science textbook in alignment with the local education system.

## Roles of Saudi Teachers and Students

Teachers have always been one of the main pillars of student achievement (Al-Nahdi, 2014), as they impart information and knowledge in a professional way in the classroom, forming an essential part of student success or failure in the whole learning process (Rotgans & Schmidt, 2011). The traditional Saudi teaching style is didactic: the teacher gives the lesson and writes the information on the white board, and the students receive it and then transfer this information to their notebook (Al-Haidari, 2006; Al-Kahtani, 2015). As a result, the classroom environment lacks dialog between teacher and student and there is little student engagement unless the teacher asks a direct question and a student raises a hand to answer (Hamdan, 2014). However, there has been increasing pressure for teachers to encourage their students in critical thinking and help them to improve problem-solving skills and creativity across their subjects (Baqutayan, 2011).

Many students have also complained that the traditional teaching method lacks excitement and deficient in critical thinking (Al-Lamnakhrah, 2013). However, Saudi cultural values encourage young people to respect their parents, elders, people, and teachers through dutifully listening and obeying (Al-Mutairi, 2007; Sonleitner & Khelifa, 2005) and this can cause students to feel uncomfortable in questioning or discussing anything with their teacher on an apparently equal basis (Al-Wadai, 2015). Students consider the teacher to be the only source of knowledge and tend to follow instructions and memorize any facts being provided without adding their own input.

Teachers need to be well prepared to be able to implement the aims of this new collaborative pedagogy to increase student participation in a meaningful way (Al-Mazroa & Al-Shamrani, 2015). Saudi teacher external professional training may not adequately prepare them to teach the new science curriculum although they have apparently found the new curriculum interesting and potentially stimulating for students (Al-Ghamdi & Al-Salouli, 2012). Such interest can help to explain the strength of subsequent teacher frustration with overcrowded class and inadequate resources (Qablan, Mansour, Alshamrani, Aldahmash, & Sabbah, 2015).

The literature also reveals language as another issue in this new reform. Although Arabic is the medium of instruction in all subject classes in Saudi school life, the new physics textbook includes English numbers, physics symbols, units, and terminology. Cook and Robert (2016) assert the importance of using the international English science language terminology to help Arabic-speaking scientists to communicate with other national communities. Learning science in the English language seems to be a gateway toward implementing science and technology for the Arab world since English is the language of science, research, computing, and communication (Ammon, 2001) and, furthermore, several researchers have commented on the difficulties of reading science textbooks in Arabic (Al-Badrany, 2014; Al-Bardi, 2013). However, aside from the difficulty of including English language, comprehending the Arabic language itself is a problematic issue for students due to the linguistic differences among the spoken language and the written language in the school textbook. The significance of developing the teaching and learning of the English language in the Saudi context has to be reconsidered to keep up with new innovations being published in English language as it is a world language (Mitchell & Al-Furaih, 2016). An alternative view suggests that learning science in the native language reduces learner misconceptions (Bayloun, 2015). Cook and Robert (2016, p. 9) however lament that "The best of the Arabic science textbooks still tend to be adapted from foreign materials and are poorly translated, missing fundamental concepts or are simply inadequate for student engagement and development of critical thinking skills." It seems that, as Baqutayan (2011) wrote, curriculum, language, and teaching method are all imperative if we wish to improve the science understanding of the next generation.

Recent research by Al-Ghamdi (2017) found that Saudi girls' positive attitude toward learning science often declines after elementary school level, with increasing boredom, particularly in physics. A positive correlation was found between students' interest in science and their understanding.

## Research Question

This study aims to identify the teachers' and learners' perceptions of the latest Saudi science reform with specific relation to physics, particularly in terms of the style of written language in the textbook and of the new teaching strategies that are required.

## Methodology

The study rests on both qualitative and quantitative data. The qualitative data came from interviews with one physics teacher from each participating school, and the quantitative data came from a survey of the students (age 15 – 16) in these teachers' grade 10 physics classes. The teacher interview protocol, as presented in Appendix Table 4, included three topics (curriculum, external resources, and language) with each topic containing two to four questions. Using open-ended questions in the semi-structured interview design allowed the researcher to engage the interviewee beyond the questions and follow emerging issues in their expression of response regarding this new reform. Most of the interview questions concerned the textbook and how teachers utilize it. Participating students completed a 47-item survey consisting of items grouped into five scales including student learning personality, attitude toward teachers, attitude toward the physics curriculum, attitude toward school, and attitude toward learning in general. Both the interview questions and the survey items were developed through consultation with experienced teachers and science educators in Saudi Arabia and Australia, contributing to their content validity. Formal validation was not considered necessary for the purposes of this study.

This mixed-methods paper focuses mainly on the qualitative data, with quantitative analysis of student survey results allowing some comparison between teacher and student perceptions. Themes from the interview data were identified separately by each of the three authors, to boost reliability of this part of the analysis. This, together with factor analysis from the survey data, enabled some triangulation across similar themes emerging from both categories of participants.

## Sample

This paper examines teacher and student perceptions of instructional materials used in contemporary Saudi physics classes. The sample of teachers and students was purposeful in the sense that three "girls only" secondary schools were chosen from each of the two Saudi cities (Jeddah and Abha). These cities were chosen because they are representative of two different regions of Saudi Arabia. Jeddah is a large coastal city and Abha is a regional city of moderate size. Table 1 sets out the number of participating teachers and students from each of these schools. Most teachers had responsibility for two physics classes, each of which included approximately 30 students.

The 12 physics classes provided 6 teacher interviews and 360 completed surveys from grade 10 physics classes taught by those teachers. Specific attention was paid to how teachers used the mandatory textbook and how they used and explained specialist physics terminology in their classes.

## Ethical Issues

Local and international ethical standards guided the design and conduct of the investigation. Local cultural priorities led to the selection of a single gender sample. The schools were chosen because they are typical of girls' schools in those cities. Consent forms were distributed to the principal and teachers to clarify the purpose and the process of data collection. After receiving the teachers' agreement to participate in this study, the interviews were conducted and recorded with institutional and participant consent. The interviews took about 30 min of teacher time, and the survey took students around 20 to 30 min to complete. Participants' pseudonyms (Teacher 1, Teacher 2, and so on) were used throughout the study in order to protect their confidentiality.

## Procedure

Semi-structured interviews allow the researcher more flexibility to extract information (Minichiello, Aroni, & Hays, 2008) and so this approach was used for the six grade 10 physics teachers. Johnson (2002) asserted the advantage of using the semi-structured

**Table 1** Participants

| Teacher | City | Teaching experience | School | Number of students |
|---|---|---|---|---|
| Teacher 1 | Jeddah | 28 years | School 1 | 65 |
| Teacher 2 | Jeddah | 25 years | School 2 | 67 |
| Teacher 3 | Jeddah | 29 years | School 3 | 59 |
| Teacher 4 | Abha | 23 years | School 4 | 58 |
| Teacher 5 | Abha | 8 years | School 5 | 56 |
| Teacher 6 | Abha | 14 years | School 6 | 55 |

interview for the researcher in that they are enabled to seek deeper information in comparison to other methods such as survey and focus group methods. The interviews were conducted in Arabic, and the researcher translated the transcripts into English. Translations were checked for accuracy by an Arabic-English bilingual colleague not engaged in this research project. The survey for students was presented in Arabic, and the completed surveys from consenting participants were collected before the teachers were interviewed.

## Data Analysis

The qualitative component of this research made use of thematic analysis, in which the categories emerged from the data. The categories or themes in this research were identified in three main categories followed by sub-categories. The main categories included textbook, content, challenges to understanding the textbook, and textbook resourcing, and teacher preparation. The results of the student survey were manually coded, and the resulting data were entered into SPSS for analysis. The 47 survey items were initially subjected to the SPSS "factor" procedure and then culled and sorted to reveal underlying factors that could be compared with qualitative information emerging from the teacher interviews. Reliability was assessed by using Cronbach's alpha to assess internal consistency, with a result of 0.832 for the whole instrument.

## Results from Teacher Interviews (Qualitative)

In line with the study's aim to identify teachers' perceptions of the science education reform with specific relation to physics, the three relevant themes identified from the data related to the new textbook and curriculum content, challenges in understanding the textbook, and teacher resourcing and preparation.

### Theme 1 Textbook Content

The data from the interviews indicated that among the six teachers, the three from Jeddah city had negative comments about the new textbook.

Teacher 1 commented that: "The old one is better than the new one", and "When I prepare for the lesson I think that the information in the old textbook was explained better. I wish that they would have kept it like it was, the students will understand it directly from their textbook when they read it but now no they can't". Regarding the new textbook she said that: "The new reform, it is student-centered; the students should depend on themselves. But we still have to help our students; some parts in some lessons need to be explained in detail".

Regarding developing students' scientific skills, Teacher 2 said: "In Grade 10 the curriculum was easy but the examples in the physics book are very hard, like elasticity, stress, iron, wire. All these topics are not appropriate for grade 10". Teacher 3 also has positive comments about the old textbook: "It was very clear. We used to write a class summary during the class. We all know that physics is a difficult subject but still it was easy to extract the information". The three Abha physics teachers had more positive attitudes toward the new textbook. Their common response regarding the old textbook was negative in relation to the content and the large amount of repeated, difficult, and ambiguous material. Teachers 4, 5, and 6 agreed that the old textbook was not clear enough for students to read. Teacher 4 stated: "It is better than the old one, which was honestly very vague. Students finished their school with zero information—they were just studying to pass exams", and she twice stressed: "*The new curriculum is amazing*". Teacher 5 explained: "The old textbook represented information in a hard way and it's hard to extract it. However, the current one is easier and it has answers to exercises, and a mathematics guideline, which the old one did not have. The current one cumulatively represents information to match students' level of ability up to three levels which means that if students are able to master the high level of scientific thinking they will have specific questions that draw this out so it really takes into account the individual level of ability".

The six teachers had dissimilar attitudes toward the new textbook organization into topics, lessons, and general presentation. The Jeddah teachers, who were more experienced, had negative attitudes toward the new textbook. They all agreed that the old one was clear, and the topics were suitable for grade 10 students. Teacher 1 mentioned that the information in the old one was "Sufficient but in the new one I feel that the information is presented as main points: headlines". She explained that the new textbook: "talks about a specific point which it hasn't talked about before or which will be in the next grade, or in a chapter at the end. Most of the information is repeated in the next chapter and so on. The old one is well organized - if it talks about one topic, it explains it and covers all the information regarding this topic". Teacher 2 argued that the topics given in grade 10 are very hard for students at their age level: "Motion and laws were in grade 11 of the old curriculum, but now they are in grade 10 which is very hard for us as physics teachers to teach our students these concepts at this level. Light and sound are very wonderful topics to teach grade 10 students". Teacher 3 focused on how the chapters were connected to each other: "In the old one the chapters were well connected from the first chapter to the second chapter and so on. The new one is not connected which means the first chapter is different from the second chapter—there is no correlation between them. The old one was clear, connected, and the definitions that were presented in the textbook were underlined. But the new one is not clear". The teachers from the city of Abha, however, were much more positive about the new textbook. In contrast to their colleagues from Jeddah, they found the new textbook to be well organized and interesting for the students. Teacher 4 commented: "The way it presents the information and concepts is very easy and everyone can easily reach the information. The old one was very vague. It was full of unnecessary information. The new one again is amazing in the way that it presents ideas". Teachers 5 and 6 held the same response that the new textbook is "Well structured. It has a summary of each chapter and a terminology list at the end of each chapter. It also has a mathematics guideline and any formula that is needed can be found in this guideline. This makes the textbook a very comprehensive reference for students" (Teacher 5).

In relation to the amount of material needing to be covered within the lesson times allocated, teachers 1, 2, 3, 4, and 6 agreed that the number of physics periods (two lessons a week) was insufficient to fulfill the pedagogical aims. They argue that the inquiry-based learning, on which the new teaching reforms are based, needs more time to cover the content. Teacher 1 said: "Two periods and 45 minutes are not enough.

Especially with this new curriculum and pedagogy we need more than the two periods even if it is 45 minutes".

Teacher 4 said: "Everything in this textbook is amazing but it needs more time. The time is not enough". Teachers 1 and 6 emphasized the density of math exercises consuming classroom time. Teacher 1 said: "I spend more time doing math because the textbooks include a lot of math exercises", while Teacher 6 commented: "The class period lengths are not sufficient. They need more time because they have a lot of exercises and problem solving to do". Teacher 5, however, found that the time was sufficient because she (like others, see Theme 3 below), did not follow the pedagogy that this new reform required. In her words: "Yes, physics periods are sufficient because I don't do the active strategies in learning. If I do it I think I would need more periods".

The three Jeddah teachers identified lack of student foundation in literacy and numeracy from previous grades as another challenge in the implementing of the new pedagogy. Teacher 1 stated: "Their foundation was wrong. Students are now suffering poor reading and writing unfortunately". She further clarified the problem she faced with students' poor foundation in mathematics saying that "The problem is sometimes with mathematics. At this stage, they should have basic knowledge in math from their previous grades in this subject. When we try to write the answers to an equation, and ask students to change symbols to number values, they struggle. They cannot answer although this is one of the most important steps in answering the math problems. I face a huge problem with their lack of basic knowledge in math". Teacher 3 also had similar struggles with her students in math. She says: "Unfortunately, some of our students in a secondary school are very weak with some of the basic things like addition, subtraction divisions. They don't know them properly". Teacher 2 added that beside their poor foundation in math, students still rely on their teachers to highlight important points in the textbook: "The new generation just rely on memorizing everything, highlighting and underlining what their teachers say is important".

### Theme 2 Challenges in Understanding the Textbook

More experienced teachers (Jeddah teachers) all commented that the textbook's use of English and written Arabic created language difficulties and were in agreement that the use of English language in the physics textbook was a source of confusion for them as they began to use it, despite their many years of teaching experience. As Teacher 1 remarked: "When I explain the lesson in Arabic and pronounce the numbers and units in Arabic but write them in English, it's really annoying". Also, "problems appear as a result of the translation. It might be I feel that there is something missing in the textbook and there is some information which is not existing, that there is something missing". Teacher 2 expanded on these comments: "I faced problems in the first year when we wrote equations in that we used to write it from right to left but then to follow the English in the textbook, we had to change that from left to right". She questioned why the textbook had to include the English language when Arabic was their native language: "From my point of view why should we include English in our textbook? This is not our language". Teachers 1, 3, and 5 gave weight to the point that their students were poor in the English language and that this new textbook hindered them from learning the units and samples effectively as they used to in the past to derive the symbols from the initial letter of the unit name which was in Arabic. Teacher 3 said: "It is difficult for them and their ability in the English language, in general, is very low" and "In the past it was easy for them to derive the symbol from the name (like Force, mass, accelerate) in Arabic".

The Abha teachers in general, however, had no difficulties with the inclusion of the English language. Teacher 4 said that while she had had a little difficulty with English in the beginning, her students had not faced any real difficulties with it overall. Teachers 5 and 6 agreed with her.

Regarding specific difficulties for students that the textbook presented, Teacher 1 had a strong negative response toward the style of Arabic language in which it was written. She states: "Sometimes I find in some parts there is a problem in the writing. I sometimes can't understand what is required—not clear. The information is clear in some chapters but often vague in others. Later I realized that the problems were in the way that the prepositions were used. For example, you can find lots of them on many lines at times yet sometimes lines are missing them as well. In addition, you can notice that there are many Arabic grammatical problems. Also there is an extra letter in a word or a missing letter from a word which requires you to read the sentence several times to understand it". Teacher 2 asserted that her students always complained that they did not like this new textbook. She stressed the point that students find difficulties in reading and writing as well. She said: "Students are facing troubles. They find difficulties in reading and writing. Yesterday I marked their exams, and I noticed that they wrote the number 40 incorrectly as 04". Teacher 3 had a similar view as she criticized the language in the textbook: "Students are suffering when reading it. They get lost—nothing is clear; neither definitions nor listings are clear". She added: "Look the physics subject is hard. Students find it hard to extract the information so if the textbook presents the information in a smoothly and clearly with headlines and clear listings as the old text book used to, then the students may understand the textbook easily, but now no, they get lost. It has to be revised again and again". She continued: "Students are struggling with physics symbols - for example; when I tell them (Force = mass × acceleration) they got it OK but when I ask them to write the formula they cannot". Teacher 5 focused on the new style of teaching and learning. She argued that students' attitudes toward learning are still following the old style. They do not understand that this new pedagogy depends on self-learning as she said: "students' attitudes toward learning and toward the subject until now—I'm still following the old style of teaching. There is no self-learning. The current curriculum is built on self-learning and students don't accept this way of learning. They still rely on their teachers to summarise and explain so they like the way of repeating what the teacher said and memorising it". All teachers agreed that this textbook was not easily readable—neither for students, nor for teachers, but the latter's experience played a vital role in coping with this textbook. They found that if any student was absent, it was impossible for them to "catch up" or understand the content of the missing lesson by reading through the textbook alone.

### Theme 3 Textbook Resources and Teacher Preparation

The interviewees agreed that there was a lack of training in teaching this new textbook. All teachers had their training for the implementation of this new textbook during the school term. They complained that the training should have been before the new school term started (during the last school days of the year before implementation). Teacher 1 said that this training caused classes to be missed but that the trainers themselves had not realized how long an effective introduction was going to take. The teachers claimed that they needed the trainers to provide explanation of the changes and their application to regular lessons, along with presentation of actual experiments enacted in front of them, step-by-step, according to the new reforms.

Further obstacles in the initial implementation of the textbook, as teacher 3 recalls, included an issue with omission of detail in the guideline teacher book answers, 3 years previously, causing teachers to struggle to find answers to mathematical exercises. The original teacher guideline to the textbook provided only final answers without showing any mathematical workings, until the modified version rectified this.

In regard to searching for resources, all teacher participants mentioned their previous reliance on external resources, although the teachers with more experience revealed that they no longer needed to refer to those external sources so frequently. Moreover, five teachers reported that laboratory equipment was not so readily available in most schools except for certain equipment needed for the new practical assessment requirements. Teacher 6 said that all tools were available in her school. Teacher 5 argued that the problem was not just with equipment needed for experiments, but that it also included challenging classroom environments, and the issue of "overcrowding of students" in each class. She remarked that all of these remain barriers for her in being able to apply the new teaching pedagogy.

Regarding the teaching strategies that they used to deliver their lessons, each teacher had a different technique according to their experience and their response. Most of the teachers found that they are still using the old style of teaching, confirming that while changes were made within the new textbook, lack of change in the classroom environments, material availability, class sizes, or number of periods to support the new teaching pedagogy made it difficult for her to apply the new strategies. As an example, the new reform required students to do a project, which would contribute 10 marks to their final score. Teacher 1 commented that it was wasting time. In her words: "In my response students are under too much pressure. They have a lot of homework; projects for each subject; and they have 9 subjects or more; so it's very hard for students to cope with all of these". Teacher 1 confirmed that she did not use any of the new strategies but that she just employed the traditional teacher-centered strategies according to the old textbook, due to barriers such as those previously mentioned. She also commented that she did not need to do any summarizing or highlighting for any lesson from the old textbook as it was so clearly laid out, but that now she feels forced to do that work for students due to overly complex lessons that were hard for students to understand. Teachers 2 and 3 expressed similar views. Teacher 2 said, "I force myself to do things that I don't like to do at all". Teacher 3 commented: "Due to the difficulties in the book, we read with the students and ask them to highlight and underline. We particularly ask them to highlight definitions, and make some sub-headings as well". On the contrary, Teacher 4 found it unnecessary to highlight with students because she found the textbook to be clear and amazing. Teacher 5 mentioned again regarding self-learning and the benefits of it provided that students understand the ideas behind this approach and apply them. She said that she always encourages group work and gives awards to students to encourage them: "We try to support students by giving them awards especially when they have group work". Teacher 2 preferred to use a variety of video clips to demonstrate information in an engaging way for students as she found that the method of providing authentic representation was preferable to decontextualised learning, which often bores students. Teacher 6 focused on how she could encourage her students to be able to write their answers according to their understanding rather than just memorizing. She said: “Write the answers to show me your understanding, not just to show me that you have memorised it”.

Teachers with greater amounts of experience are able to adapt themselves to this reform, including the barriers that they faced in the beginning, by drawing on their skill and experience to assess the most effective strategies that students need in order that the teachers could successfully cover all the textbook content that they need to teach.

Teacher 2 (25 years experience) and Teacher 4 (23 years experience) both advised other teachers to be collaborative and constructive in their communication with each other, sharing their experiences in order to gain collective expertise. Teacher 2 focused on how teachers can prepare their lessons. She first advises that teachers divide any hard lessons into parts (even math exercises), and to make sure that students fully understand current content material before she moves on to new parts of the lesson. She advises, “If the lesson is hard you have to divide the lesson into parts and try to make a revision after each point”. Teacher 3 (29 years experience) always depends on her experience when extracting information after reading it from the textbook. She also advises other teachers to search for and refer to external references like finding experiments and not just sticking with the textbook. She encourages teachers to borrow information from external sources: “You do not have to stick with the textbook experiments”. Teacher 4 finds that it is expedient for teachers to go to their students’ level and not feel they need to explain everything but to encourage students to think, discover, and engage themselves with the lesson content on their own rather than just relying on memorizing everything. She believes that using group work in her classroom is an effective strategy to activate student-centered learning: “Using the group work strategy is very effective. The most important thing is to keep students participating in the lesson”.

## Results from Student Survey (Quantitative)

In order to identify Saudi grade 10 learners’ perceptions of the science reform with specific relation to physics, the data from the student survey was subjected to initial factor analysis. The Kaiser-Meyer Olkin measure of sampling adequacy was low (KMO = 0.467) and Bartlett’s test of sphericity was significant ($\chi 2 = 2627.319$, $p = 0.000$), suggesting that the data from the 47 items was not suitable for factor analysis. Items which showed factor loadings of greater than 4.00 were then selected from the original data, and reanalysis revealed that the 17 remaining factors explained 54.53% of the total variance, with “suitable” sampling adequacy (KMO = 0.755) (Allen & Bennett, 2010, p. 204) This reanalysis reduced the 17 items to seven factors, each factor comprising between 1 and 4 items. The rotated component matrix allowed identification of the items that loaded high on each factor. Examination of the item loading high suggested the following components of the student response data (see Table 2). A single question serves as surrogate for the other items loading onto the particular factor (Hair, Anderson, Tatham, & Black, 1995). The item numbers of these

**Table 2** Questionnaire items responding to each surrogate

| Factor | Factor surrogate item | Factor surrogate responded |
|---|---|---|
| Positive attitude to physics learning | Item 37 | "Love laboratory lessons" |
| Supportive school environment | Item 22 | "School good environment" |
| General literacy | Item 36 | "Read things not connected to school" |
| Physics readability | Item 20' | "Understand after reading textbook" |
| Positive attitude toward science | Item 21 | "Love science TV shows" |
| Help at home | Item 23 | "Sibling helps with homework" |
| Teacher uses Modern Std Arabic | Item 7 | "MSA in class" |

surrogates appear in the second column in Table 2, in order of their sequence in the full questionnaire. The full set of items corresponding to each factor is in Appendix.

Table 3 shows the percentage frequency of the student responses to the seven factors, represented by their surrogate items.

The table shows the factors extracted from the student survey. This group of 360 students seemed to like learning physics and laboratory activities (Table 3, Item 37). This group of students seems more ambivalent about the school environment, reading books outside of their school context, the readability of their physics textbook, and learning science in general. The family support factor was very low as relayed by the

**Table 3** Student responses to factor surrogates

| Factors | Mean[c] | Std. dev.% | Almost every day (6) | Often (5) | Sometimes (4) | Not very much (3) | Very rarely (2) | Never (1) |
|---|---|---|---|---|---|---|---|---|
| | | | Strongly agree[a] | Agree[a] | Little agree[a] | Little disagree | Disagree[a] | Strongly disagree[a] |
| 1. Positive attitude to physics learning | 4.65 | 1.23 | 26.1(94)[b] | 35.8(129) | 26.1(94) | 5.3(19) | 2.5 (9) | 3.9 (14) |
| 2. Supportive school environment | 3.98 | 1.76 | 26.4 (95) | 19.4(70) | 15.6(56) | 14.7(53) | 12.5(45) | 10.8(39) |
| 3. General literacy | 3.92 | 1.99 | 35.3(127) | 13.6(49) | 12.2(44) | 6.7(24) | 10.8(39) | 21.4(77) |
| 4. Physics readability | 3.13 | 1.63 | 7.2(26) | 16.4(59) | 21.4(77) | 18.1(56) | 11.7(42) | 24.7(89) |
| 5Positive attitude toward science | 3.29 | 1.80 | 15.8(57) | 14.2(51) | 18.1(56) | 12.8(46) | 14.2(51) | 24.7(89) |
| 6Help at home | 2.85 | 1.90 | 12.2(44) | 14.2(51) | 14.4(52) | 7.5(27) | 10.3(37) | 40.0(144) |
| 7Teacher uses MSA | 3.19 | 1.81 | 10.6(38) | 20.9(75) | 15.9(57) | 13.6(49) | 10.9(39) | 25.3(91) |

Notes:

[a] Likert scale: agreement (scale was frequency for the other items)

[b] % (number)

[c] Mean Likert "score" from a six point scale

students' responses in the survey. Almost half of these students reported that their physics teachers did not use modern standard Arabic inside the classroom (using local Arabic dialects instead).

## Discussion

This discussion highlights the major themes that emerged from the teacher interviews and triangulates these with themes that emerged from the student surveys. The responses under several factors from the student surveys connect with themes from the teacher interviews; no major discrepancies were found between teacher and student responses. Teachers were, understandably, more informative about the practicalities of instruction, while student responses indicated how these impacted on them.

Both teachers and students seemed concerned with the importance of using experiments to deliver knowledge, as the students responded strongly to two survey items (see Appendix) indicating their preference for using experiments. However, teachers remarked that the tools provided for in-class experiments were often limited to those that were required for students' practical exams and complained about the lack of choice in the range of available laboratory tools.

However, the data generated from the interviews indicated contrary responses among teachers toward the change in textbook. Jeddah teachers (more experienced) expressed more negative attitudes toward this new textbook, that it was difficult for students and required extra help from their teachers. Abha teachers seemed to be find this new textbook more interesting. Among students, nearly 40% responded that the textbook's design and color made it easier to understand, while 43% of the student sample answered that they found that the textbook in general was not clear. Students' responses thus echoed ambivalent teacher responses regarding the usefulness of the new textbook.

Although the less experienced teachers (Abha teachers) were happier with the curriculum reform, all of the participating teachers still followed the old traditional style of teaching, which is consistent with findings from other studies (Al-Dahmash & Al-Shamrani, 2012). Although the participants seemed initially excited about shifting their traditional method of teaching to the student-centered inquiry-based learning approach, lack of classroom equipment, laboratory instruments, class sizes, and shorter class periods all contributed to teacher reversion to traditional teacher-centered methods. As there was little variation in class sizes, there was no opportunity to investigate whether smaller classes would have assisted student-centered teaching. Some teachers reported using group work or ICT if they were available and argued that the impediments described above acted against their desire to fulfill this new reform, as also found in other studies (Al-Ghamdi & Al-Salouli, 2012). Transforming teaching approaches requires time to enable teachers to use them effectively (Fogleman, McNeill, & Krajcik, 2011).

Students' preference for learning through experiments, mentioned above, suggests a positive attitude to more student-centered learning in science. Students were ambivalent about whether their school was a good environment for studying, and few felt that it was like a second home. Relatively few students felt that their school supports independent active learning through research or experiments outside the school. More than half the student participants, however, found the school lab technician to be helpful in their practical work.

Focusing more specifically on the textbook, the more experienced teachers emphasized problems with the written language presented in the textbook. These teachers raised the issue of language problems in the textbook material translated from foreign sources. They highlighted a loss of clarity of meaning after translation issuing from grammar irregularities, particularly the unclear use of prepositions, causing issues in how the sentences were presented in the passages. One of these teachers stated that they felt that there was something missing in the writing.

For learners, learning to understand the language of science is just as essential as the learning of science itself. This situation is further complicated in the Saudi context as all textbooks are written in modern standard Arabic (MSA), which is derived from classical Arabic and differs vastly from the spoken Arabic language in its numerous and diverse local forms (Al-Mamari, 2011; Wahba, 2006). The use of scientific English terminology and language in the recent textbook compounded these difficulties. These teachers struggled in the beginning of this new reform as they complained of the lack of preparation and adjustment of practice to the new reform. Using English symbols and terms in the physics units, symbols and numbers can cause confusion for the learner. In the past, learners used to associate the units and symbols with their initial letters because they were written in the Arabic language, but their weakness in English might cause an obstacle for the learning of physics. A majority of student responses confirmed that they found the use of English in the physics book a source of difficulty. Their responses confirmed that not all teachers used the modern standard Arabic of the textbook in their teaching, using local dialects instead, and not many teachers translated the English terms into Arabic.

These points of view have not been deeply investigated in previous literature with regard to the new Saudi education reform. Our findings support the suggestion that the importation of a foreign, albeit “global” or “common,” curriculum reform into a different cultural and educational setting, as mentioned earlier often contributes to an unsuccessful reform. A deeper investigation targeting specific language difficulties presented by the textbook is reported in Albadi, O'Toole, & Harkins (2017).

All teachers mentioned the difficulty for students in understanding their physics textbook easily, if they had to catch up on reading through being absent from class for any reason. This issue reflects a difficulty for students in their ability to access the content in their physics textbook. This crucial matter was raised even from the positive teachers who had found this new textbook to be attractive and exciting. Students’ survey responses indicated ambivalence about being able to extract meaning from the textbook without help and toward reading about science in general. The style of scientific language used could be the source of this difficulty, as noted above. Students also indicated relatively little enthusiasm about independent reading in general, whether or not it relates to their schoolwork. Some students accessed help with their learning at home, but the overall picture is that they need the teacher’s help to learn effectively.

More experienced teachers in this study admitted to having to employ particular teaching strategies such as reading the physics textbook with their students first and highlighting particular areas that they feel would be difficult for students to understand in their own reading, thereby simplifying the lesson to enable access to the textbook’s content for all students.

Adequate training and sufficient teachers' preparation were another issue raised in this investigation. Although the teachers acknowledged that they did receive training throughout the initial stage of this reform after implementation (El-Deghaidy, Mansour, & Al-Shamrani, 2014), some teachers in this study expressed indifference toward attending the training sessions, as they regarded that the program was wasting their valuable class time. Insufficiency and mismanagement of teacher development programs in the beginning of this reform caused time conflicts with their class lessons and a feeling of inadequacy. Teachers apparently needed more time to engage in collaborative modeling of implementation of the new textbook (El-Deghaidy, Mansour, Al-Dahmash, & Al-Shamrani, 2015). The importance of such effective training workshops was illustrated in Mansour, El-Deghaidy, Al-Shamrani, and Al-Dahmash (2014) who highlight the significance of giving teachers an authentic lesson and to allow them to share and reciprocate their experiences rather than being restricted to just passing on the instructions received directly from the Ministry of Education. Teachers need to be immersed and instructed about how to shift their teaching method from the traditional one to a student-centered (inquiry-based learning) method (Al-Mazroa, 2013). Some teachers stated that they did not receive any training or instructions before the commencement of the new reform. The more experienced teachers seemed very confident of their ability to teach this new textbook, notwithstanding their negative attitude to it, but cited time constraints as cause for their difficulty in implementing the new collaborative teaching strategies. This finding contrasts with the findings of Al-Ghamdi and Al-Salouli (2012) which revealed that more experienced teachers were found to be effective and amenable toward the new curriculum.

The experienced teachers in this study relied on their knowledge and past experiences and therefore did not tend to refer to resources beyond the textbook. On the contrary, the less experienced teachers more frequently referred to external sources for subject content.

## Conclusions and Implications

This current exploratory research investigated the female physics teachers and learners' perceptions toward this new reform with specific attention to their response to the new physics textbook in comparison to the former one, the language used in this textbook, and finally their use of external resources rather than adhere to those solely within the given textbook. Learners' perceptions grouped under factors including attitude to physics, school environment, general literacy, physics readability, attitude to science, help at home, and teacher's Arabic usage.

Many criticisms had emerged from Saudi educators demanding an urgent reform of the Saudi curriculum, in particular science (Al-Tawil, 2013), leading to a new science curriculum reform which started in 2009. Notwithstanding the variety of perceptions among the participants toward the new textbook, the data drawn from the teacher participants suggests that traditional teaching remains the dominant method in this new science reform, at least with regard to physics. Teachers reported that difficulties in shifting their teaching methods were due to insufficient training, insufficient classroom time, excessive class sizes, insufficient ICT equipment, and the design of the textbook.

Thus, the policy, curriculum intentions, resources, and classroom experience do not appear to line up.

Constructive alignment has five components, enumerated by Biggs (2003, p.26) as "the curriculum, teaching methods, assessments and methods of report result, the climate we create in our interactions with the students, and the institutional climate, rules and procedures we have to follow". Misalignment of these components in the education system would negatively affect teaching quality. Teacher development and preparation programs to adapt to this new reform criteria should be available (Al-Mazroa & Al-Shamrani, 2015; Hamdan, 2015). The instances of non-alignment of these aspects found in this study illuminate the fact that Saudi policymakers in the science education reform have not adequately addressed all alignment components to fulfill the aims of this reform.

The action of borrowing a foreign American physics textbook to inform the redevelopment of a new Arabic physics textbook was another issue that emerged from this study. Participants reported what they felt was unsuitability of adoption of this textbook. Both teachers and students cast doubt on the readability of the physics textbook. The issues uncovered in the Saudi textbook were twofold, and it is evident that this is an area that can yield further information. Firstly, the specialist science language represented in the physics textbook lost its accuracy of meaning through the process of translation from English into Arabic. Secondly, the modern standard Arabic used in the textbook differs from the spoken language that the teachers were frequently using in the classroom, consistent with the general patterns of Arabic diglossia. Both issues cause students difficulty in accessing the physics textbook and impact their learning of the Arabic language itself (Al-Mamari, 2011) due to the inadequate Arabic translation of the original English meaning and also the difficulty with understanding the Modern Standard Arabic text due to the fact that while it was in their textbook, their teachers were not speaking it in class. In light of these findings, this study highlights the necessity of an integrated and collaborative effort by all stakeholders under the Ministry of Education to fine-tune the problematic issues of the "globalizing" of the physics textbook and the implementation of the new reform, including plenty of opportunities for teacher and learners to have input into the practical implementation of such reform.

Limitations of this study however should be noted. The participant sample was restricted to a specific sample of teachers and students, selected for the purpose of comparing across the two groups, and may not be fully representative. It was conducted in a girls' school due to the cultural values and rules in Saudi Arabia which ensure school gender segregation. While the results are thus not fully generalizable, they are timely in view of recent Saudi policy emphasis on women's education and careers, and the learning issues that emerged are of likely relevance regardless of the learner's gender.

It can be concluded from the findings of this study that further research is needed in terms of the policy and preparation for the implementation of this new curriculum as it should be in alignment with all policy requirement components. Moreover, research could expand the sampling of this investigation into boys' schools and examine any comparisons among school genders. Another key finding is that the language used in Saudi school textbooks is not accessible to different reader ability groups. Therefore, it is suggested that language comparisons among written and spoken language varieties be further investigated.

## Compliance with Ethical Standards

Local and international ethical standards guided the design and conduct of the investigation.

## Appendix

**Table 4** Teacher's interview questions

| Topic | Questions |
|---|---|
| Curriculum | • Can you please compare between the old and the new physics curriculum (e.g. adequacy, features)? Do you think that the new curriculum achieves the aims that have been designed for? What do you recommend?<br>• How do you find students' interaction with this new curriculum?<br>• What do you advise other teachers to help student to cope with? |
| Resources | • Do you think that the number of weekly physics classes is enough to cover the whole curriculum? If yes, what do you suggest for the access time? If not, how many weekly classes do you suggest? Why?<br>• Do you refer to external resources to prepare lessons? Please specify if yes. If not, do not you think that it is better to refer to external resources in addition to the textbook?<br>• Do you encourage your students to search for new information? Why?<br>• To what extent do you refer to foreign external references to prepare lessons? How easy is doing that? |
| Language | • Do you experience difficulties in using English and Arabic at the same times? What is the best for students to use? And for you?<br>• Do you use English numbers, names of units, and physical symbols or do you just use the Arabic ones? Why? |

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