The Inclusive classroom: Effect of a readability intervention on student engagement and on-task behaviour within two mixed-ability science classrooms

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Abstract

In Ireland, teachers are expected to differentiate the curriculum to meet the needs of an increasingly diverse range of students. The purpose of this study was to compare the effects of using commercially-available worksheets with universally-designed worksheets on student engagement and on-task behaviour within two mixed-ability science classes in an urban community school. The universally-designed worksheets began with questions that were carefully matched with students who traditionally struggled with independent worksheet completion. In an effort to challenge all students, subsequent questions on the universally-designed worksheets required increasing levels of literacy in a graded fashion. The results of this study indicate that the use of universally-designed worksheets can improve student engagement and on-task behaviour during independent timed worksheet activities within mixed-ability science classrooms.

Keywords: Inclusive science, readability, on-task behaviour, student engagement.

Introduction

The increasing diversity of students in Irish classrooms poses new challenges and opportunities for teachers. A need to differentiate the curriculum to meet the diverse needs of students including those with special educational needs is evident. The publication Inclusion of Students with Special Educational Needs: Post Primary Guidelines encourages teachers to choose learning materials, including textbooks and worksheets that are suitable for students with special educational needs (Department of Education and Science, 2007). These guidelines list a number of variables that contribute to reading comprehension, such as organisation of the material, syntax, word length, sentence length, word frequency, typeface and line-spacing. The guidelines also suggest the use of readability formulas to help teachers match text to the literacy skills of students.

Research in the UK has shown that many teachers use simplified language materials that use shorter words and sentences, with fewer clauses and passive forms (Rix, 2006). However, the use of simplified language to enhance the learning experiences of students is open to debate. For instance, Hayes et al. (1996) argue that the decline in the verbal scores of US aptitude tests may be due to the use of simplified readers in schools, while Mishan (2005) suggests that language simplification impedes language acquisition. Furthermore, the use of simplified

learning materials designed specifically for a small group of students within a mainstream class may impact negatively on those students' identities (Rix, 2004) and may be insensitive to their changing needs (Brumfit, 1992). Conversely, other researchers have shown that simplified texts can promote comprehension (Tweissi, 1998). In addition, many teachers believe that simplified texts improve access to the curriculum (Rix, 2006).

Academic learning time is related to the time in which students are productively engaged in learning and is closely associated with learning outcomes (Gettinger and Stoiber, 1999). It is composed of two parts, procedural engagement, such as task completion and substantive engagement, such as the amount of text comprehended (Nystrand and Gamoran, 1991). Procedural engagement can be readily observed but substantive engagement concerns the student's active involvement in the learning task (Reeve et al., 2004) and is not as easily measured (Fredricks et al., 2004). However, substantive engagement can be measured through student self-report measures (Appleton et al., 2006). Furthermore, measuring on-task behaviours may be a useful method for assessing students' procedural engagement with learning (Shapiro, 2004; Spanjers et al., 2008). On-tasks behaviours include behaviours, such as looking at a worksheet, listening to instructions and answering questions.

The role of setting events or antecedents may be just as powerful in shaping and influencing behaviour as contingencies or reinforcement (Glynn, 1982). Teaching practices that are considered to be effective in general and tend to be used by teachers who have positive beliefs about inclusion, are especially effective in preventing and dealing with off-task behaviours (Mayer and Patriarca, 2007; Stanovich and Jordan, 1998). Furthermore within classrooms, antecedents may be more amenable to modification and hence may provide a more efficient strategy for improving behaviour than using reinforcement alone. Research by Bru (2006) indicates that perceived cognitive competence is a predictor of on-task behaviours. Therefore, antecedent classroom interventions that facilitate student learning and facilitate perceived cognitive competence may increase on-task behaviours.

The controversy surrounding the use of simplified texts highlights the need to use simplified language sensitively as just one component of learning and teaching. In this study, preliminary functional behaviour assessment for individual students with relatively low recorded reading ages had indicated that off-task behaviours increased during independent student activities that involved completing worksheets or textbook questions with a relatively high reading age. The main aim of this study is to test whether adjusting the readability of worksheets by applying the principles of universal design for learning as outlined in the following section, can improve student engagement and on-task behaviour within a whole-class setting.

Method

Participants
The participants for the study were 45 students in the second year, attending one large urban community school in Ireland with a relatively equal distribution of males (n=23) and females (n=22). The students who ranged in age from 13.4 years to 14.8 years formed two mixed-ability science classes. The sample included newcomer students (n=4), students with dyslexia (n=2), a student with borderline mild general learning disability and a student with attention deficit hyperactivity disorder (ADHD).

The Teaching Council in Ireland publishes Codes of Professional Conduct for Teachers, which set out the standards of professional practice and conduct appropriate to the profession (The Teaching Council, March 2007). These codes highlight the role of reflection in teacher professional development. Teachers draw on practitioner-based research to plan for learning and teaching through continuous reflection on their own current practice. In this context, the teacher readily agreed to participate in the research. Notices were sent to the parents/guardians of all students within the two science classes informing them of the teacher's intention to adapt worksheets to explore learning opportunities for students and providing them with the opportunity of requesting their child's non-participation in the research. All students were allowed to participate.

Worksheet Design
Worksheets for the readability intervention were universally designed based on the following criteria:
1. The reading age of initial questions within each worksheet are matched to students with the lowest reading ages in the classroom but increase in reading age and complexity in a graded fashion.
2. Complex words and sentences are minimised.
3. Visuals have a clearly defined purpose.
4. The level of writing required by the student is evident from the spaces provided.
5. Initial questions use matching exercises, cloze tests with key words provided or other content that does not require extended writing.

Such criteria are similar to the guidelines used to develop universally designed assessments in the US (Johnstone et al., 2006). This approach is used by O'Leary (2008) to differentiate learning and teaching in science for students with diverse needs and abilities.

Reading Age of Text
A computer-based readability formula calculator was used to determine the readability statistics of three commercially available standard worksheets and three universally designed worksheets by calculating a mean reading age for each worksheet. The formulas used include the Flesch–Kincaid Grade Level formula (Flesch, 1974), the McLaughlin SMOG formula (McLaughlin, 1969) and the Gunning FOG formula (Gunning and Kallan, 1994). The Flesch–Kincaid Grade Level formula evaluates readability as the average number of words per sentence and the average number of syllables per word. The McLaughlin SMOG formula counts a single variable, the number of words in the sample containing three or more syllables while the Gunning Fog formula counts the numbers of words, polysyllabic words and sentences.

Time on Task Data Collection
Prior to data collection, the teacher practiced measuring the on-task behaviour of first year students during ten minute sessions of independent reading and writing activities. On-task behaviour was defined as actively attending to a worksheet through reading, writing, asking appropriate questions or listening to instructions from the teacher (Shapiro, 2004). On-task behaviour was assessed using a momentary time sampling with 30 second intervals, similar to the method of Hintze et al. (2002). To establish a baseline, the teacher collected data over a two week period. This was achieved by observing on-task behaviour from both second year science classes during three separate ten minute sessions of independent student work using standard commercially available worksheets. Next, the teacher observed on-task behaviour within a further two-week period from both second year classes during three separate ten

minute sessions of independent work using the universally designed worksheets. Overall, each data collection session ranged from 12 to 15 minutes in length. To convert the data to a proportion, the number of students that were deemed to be on-task for each 30 second interval during the ten-minute session was divided by the total number of students multiplied by the total number of intervals.

Student Engagement
The Effort and Persistence in Learning (EPL) subscale of the Student Approaches to Learning Survey (Artelt et al., 2003) was adapted to measure student engagement. After each worksheet session prior to and during the readability intervention, students were provided with a three-item self-report questionnaire regarding their level of engagement with their learning during the ten minute worksheet activity. Students were asked to rate themselves on a scale of 1 to 4 (strongly disagree to strongly agree) for three items: (a) I worked as hard as possible, (b) I kept working even if it was hard and (c) I tried my best to learn what was taught. Self-report ratings data of the three items were added together to give a total engaged score for each student, which ranged from 0 to 12.

Results
Table 1 lists descriptive statistics (means and standard deviations) for the reading ages of the six worksheets used in this study, three of which were standard commercially available worksheets and three of which were universally designed worksheets based on criteria discussed earlier. An examination of the reading age of each worksheet using the three readability formulas yielded different reading ages. This is expected as each readability formula measures different textual criteria. However, in each case, the mean reading ages of the three universally designed worksheets proved to be lower than the mean reading ages of the standard worksheets for each readability formula. This trend is reflected in the mean reading age of each worksheet.

Table 1. Means and Standard Deviations (SD) of Reading Age of Text for Standard Worksheets and for Universally Designed Worksheets using three different procedures.

Worksheet		Flesch-Kincaid	Gunning FOG	McLaughlin SMOG	Mean Reading Age	SD
Standard Worksheets	1	10.3	12.8	14.6	12.57	1.76
	2	11.4	13.5	14.8	13.23	1.40
	3	10.5	12.3	14.1	12.30	1.47
Universally Designed Worksheets	4	8.9	9.8	11.5	10.07	1.08
	5	8.7	9.5	11.4	9.87	1.13
	6	9.7	10.1	11.5	10.43	0.77

Table 2 lists descriptive statistics for the three variables in this study i.e. reading age of text, time on task and student engagement. Time on task was correlated with the reading age of text using the Pearson product-moment. A significant correlation was found (r= -0.908, p<0.01) that suggests a negative relationship between the two variables. The lower the mean reading age of the text, the more time students spent on task. Student engagement, as measured using student self-reports was also correlated with the mean reading age of text (r= -0.821, p<0.01). In other words, students reported working harder when the mean reading age of the worksheet was lower.

Student engagement was positively correlated with time on task (r= 0.742, p<0.05), though to a lesser extent than the reading age of text. Students reported working harder when they had

spent more time on task, though it appears from the data that other factors may also influence student self-reports of engagement.

Table 2. Means and Standard Deviations (SD) for Reading Age of Text, Time on Task and Student Engagement (i.e. student self-reports) during Worksheet Activities (n = 45)

	Standard Worksheets		Universally Designed Worksheets	
	Mean	**SD**	**Mean**	**SD**
Reading Age of Text	12.70	1.54	10.12	0.99
Time on Task	79.63	7.56	93.67	6.18
Student Engagement	10.01	1.39	10.79	1.48

Discussion

The data presented in this study suggests that the reading ages of texts used in independent student activities strongly influences both student behaviour and student engagement in the classroom. Lowering the mean reading age of worksheets improves on-task behaviour and student engagement. Similar findings have been reported by Uekawa et al., (2007) who reported that the difficulty level of content influenced student engagement and by Spanjers et al., (2008) who found partial correlations between time on task and self-reported student engagement. Task difficulty has also been found to affect time on task (Burns and Dean, 2005; Treptow et al., 2007).

It is important to note that in this study, it is the mean reading age of the worksheet that is lowered. This does not suggest that the reading age of the entire worksheet is unsuitable for higher-ability students. Rather, the reading ages of the initial questions in the universally designed worksheet was lowered to match students in the classroom with poor literacy skills. Students with higher reading ages could still be challenged by either the scientific concepts outlined in the worksheet or by text that is used in the later stages of the worksheet.

The use of universally-designed worksheets provides a mechanism for teachers to address the concerns reported by Hayes et al., (1996) and Mishan (2005), which suggests that language simplification impedes language acquisition. It also allows teachers to overcome the challenges highlighted by Rix (2004) and Brumfit (1992) by supporting students changing needs without negatively impacting on students' identities. The link between on-task behaviour and student self-reports of engagement found in this study agrees with the work of Bru (2006) who suggests that perceived cognitive competence is a predictor of on-task behaviours. It seems intuitive to suggest that students who exhibit improved on-task behaviour and report greater engagement when using universally-designed worksheets experience a greater sense of cognitive competence, though this tentative conclusion requires much additional research. Furthermore, other aspects of teaching and learning, such as teacher-student relationships, peer relationships, teacher beliefs about inclusion and teacher interactions with students throughout the lesson were not addressed in this study.

This results reported in this study suggest that simplified language materials that use shorter words and sentences can be incorporated into universally-designed worksheets within mixed-ability classrooms. This study also demonstrates the potential antecedent role of the teacher in adapting teaching and learning to prevent off-task behaviours. It seems likely that the use of consequences or reinforcement will be more effective in classrooms that seek to understand the impact of antecedents on student learning. Student engagement is critical to establishing an appropriate classroom environment and is consistently linked to positive academic outcomes (Gettinger and Stoiber, 1999; Nystrand and Gamoran, 1991). Further research could

investigate the effects of universally-designed worksheets on student comprehension and academic progress or seek to explore the role played by other antecedents in shaping student behaviour within inclusive mixed-ability settings.

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