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A Time-on-Task Analysis of Teaching and Learning Productivity

Abstract

This paper presents the use of the time-on-task analysis (TOTA) diagnostic model as an instrument to improve the efficient management of allocated academic time in schools and focuses on the descriptive analytics produced by the TOTA model. The model aims to analyse how time is spent during the school day to enable school leaders, managers, and teachers to identify opportunities for improving teaching and learning 'uptime' in their schools and classrooms. The theoretical underpinning of the TOTA model is overall equipment effectiveness (OEE), a powerful analytical productivity metric used widely in manufacturing, and thus provides a novel perspective on how time is spent in the school day. The descriptive analytics are based on a data set of 450 observations taken during a time-series classroom observation study in the intermediate-senior phase of a primary school. It is argued that the TOTA model can be a valuable tool for school managers and teachers to improve teaching and learning productivity through the efficient utilisation of allocated academic time. The time-on-task analysis presented in this paper further underscores the importance of teachers' classroom management competencies and has the potential to be a valuable tool to enhance the instructional and transformational leadership practices of school principals.

Keywords: time-on-task, time management in schools, classroom management, effective teaching and learning, education productivity, quantitative classroom management studies, instructional leadership

Introduction

Schools and universities supply the economy with one common resource: educated labour. Hoxby (2004, p. 209) calls it the quintessential upstream industry. However, it is noted that where most industries have seen a rapid and consistent increase in productivity over four decades (Creighton, 2016), the pedagogues, economists and policy makers agree that the education sector's productivity has been steadily declining (Hoxby, 1999; Ahlgrim, 2010; Creighton, 2016).

The productivity metric most dominant in literature, and generally used at policy level, is that of learner achievement on standardised tests per dollar spent (Ahlgrim, 2010; Lafortune et al., 2018; Hoxby, 1999). Even after moderating for school expenditure inflation, Gundlach et al. (2001, pp. C135-C147) found that education productivity had indeed declined in the countries in the scope of their study.

Because the world of work is placing an increasing demand on both cognitive and non-cognitive skills that are to be developed by education systems, economies cannot afford the education sector falling behind in its delivery of these skills. In the school

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context, Brauckmann et al. (2023, pp. 4-15) argue that meaningful research-based knowledge of local school contexts and action-specific interventions are required through for example instructional and transformational strategies by school principals to improve education's productivity problem. Among others, school leaders and managers can positively influence teaching and learning productivity at school level by effectively organising and planning instructional time to promote efficient 'time-on-task' (Leithwood et al., 2020, pp. 5-22).

This research demonstrates how the TOTA model can be used to study the local school context to highlight opportunities for action-specific intervention by principals and teachers to increase productivity through the reduction of time-on-task losses. The TOTA model does this on a more detailed, systematic and practical level than what has been done to date in similar studies (Doyer & Bean, 2023).

This paper will present further literature on productivity in schools, after which the research methodology used will briefly be described, before the results of the study are discussed.

Literature review

A wide range of factors influence productivity in education and come from fields of study as diverse as policy, sociology, genetics, leadership and pedagogy. However, at school and classroom management level, two factors dominate others: the quality of teaching, and the amount of time spent on task, the latter especially in those subjects addressing literacy and numeracy. Quality of teaching, for example, trumped class size, aptitude-based grouping of learners, and type of school system (Sanders et al., 1997, pp. 57-67) as well as learner achievement (Sanders et al., 1997; Gerritsen et al., 2017).

Financial expenditure per learner and the type of school governance had a relatively small impact on learning (Ahlgrim, 2010; Hoxby, 2003), but along with teaching quality, time-on-task had a significant impact on learner achievement, especially in literacy and numeracy (Hoadley et al., 2009; Stallings, 1980). Hoadley et al. (2009, p. 378) argue that organisational aspects such as time management and the structuring of the school day are fundamental to enabling good quality teaching.

A literature review on quantitative classroom observation studies revealed that such studies are relatively rare, but where they do exist, they have a pedagogic or sociological focus, but time-on-task has received little focus to date (Apter et al., 2020; Wragg, 2011). The Stallings (1980, pp. 11-16) studies were one of the few examples where quantitative classroom observation studies had a time-on-task focus. Although focused and widely representative, the studies did not do a systematic and analytical study of the complete school day, but rather focused on specific factors.

Expanding on the practical work of Stallings (1980, pp. 11-16), and building on the theoretical basis of a widely-used diagnostic productivity metric used in manufacturing, Doyer and Bean (2023) developed the time-on-task analytical (TOTA) model. This paper showcases the descriptive statistics produced by the model to give empirical feedback to principals and teachers on opportunities for maximising time-on-task in the school day.

Research methodology

A secondary data set was obtained from a private school in South Africa, which contained 450 observations made during a total of 44 school periods, or 1320 minutes,

of the intermediate-senior phase of the primary school. The observations were made by shadowing three different teachers as well as a grade 5 class while doing a time-series observational study.

In terms of time observed, the secondary data set was between 20% to 66% in scale to what Apter et al. (2020, pp. 367-385) describe as the "mass" or "large" quantitative classroom studies done to date internationally. Although this data set covered eight different teachers, using a combination of nine different instructional styles and methods at various points of the school days observed, to teach ten different groups of learners in seven different subjects, the data set was taken over four school days and is thus not representative of all school days, but does demonstrate the abilities of the TOTA model in analysing a school day from two different perspectives.

The school observed is well equipped with teaching resources such as projectors in all classrooms. Tablets are available but used for specific subjects and assignments only. Class sizes range between 20 and 25 learners and all classes are made up of learners from at least three ethnic groups. Teaching follows a mostly traditional approach, but the school incorporates more progressive approaches such as learner-led projects, 21st century skills training, etc.

The data set contained the starting time of each sequential activity, as well as the description of the activity observed, and additional field note observations. The detailed, time-series observations provided a rich source of data to be processed into the different school day loss and activity categories of the TOTA model.

Once the data had been coded into the TOTA model categories, descriptive statistics were used to visualise the school day from two different perspectives: that of the teacher and that of the learner. The insights gleaned from the TOTA model are presented next.

Results and discussion: a day in the life of a teacher

Table 1 contains the results of the TOTA and indicates how the TOTA model systematically breaks the school day into more and more detailed categories to provide principals and teachers with detailed feedback on how a teaching day is typically spent at the school. As can be seen from the analysis, this school had 75.4% of the school day scheduled for academic time, but only 32.4% of the teachers' school day was spent 'on task'. Time on task is defined by Doyer and Bean (2023, preprint, p. 14) as "Time spent paying attention, or trying to learn. The amount of time students are engaged in academic work."

The purpose of the TOTA exercise is, however, NOT to measure teacher productivity, but rather to diagnose productivity losses in such practical detail that makes improvement opportunities apparent to both teachers and school management. Referring to the detail level of Table 1, the five biggest losses of allocated academic time for the teachers in the school days observed were:

1. Set-up academic (capturing marks).
2. Set-up academic (work instructions), typically a teacher explaining an assignment or class activity.
3. Time-on-task losses (speed loss / idling), which Doyer and Bean (2023) define as learners being disengaged (idling).
4. Interruptions – external (administrative), with the field notes indicating that these were conversations with school management and the study officer.
5. Set-up logistics (class changeovers).

Together, these five losses constitute 32.7% of the teachers' school day. It is interesting to note that none of the teachers' days were spent preparing for lessons during school time, although the teachers were clearly well prepared. This could mean that teachers prepare for lessons after their sporting duties in the afternoons.

Table 1: Breakdown of teacher school days using the TOTA model

Scheduled non-academic time 24.6%			**Events** 6.5%	Routine	0.9%
				Non-routine	5.6%
			Breaks 10.1%	Formal	7.6%
				Informal	2.5%
			Set-up allowance 8.0%	Teaching preparation	3.0%
				Meetings	5.0%
Scheduled academic time 75.4%	**Availability losses** 34.8%	**Interruptions 7.4%**	**External** 6.7%	Administrative	5.2%
				"Drive-by"	1.5%
				Maintenance	0.0%
				Resource availability	0.0%
			Internal 0.7%	Discipline issues	0.0%
				Off-topic discussions	0.7%
		Set-ups 30.2%	**Set-up logistics** 7.8%	Class changeovers	4.7%
				In-class configuration	3.1%
			Set-up academic 19.2%	Progress monitoring	1.6%
				Work instructions	5.5%
				Capturing marks	12.1%
			Set-up non- academic (administration)		3.2%
	Available academic time 42.2%	**Time-on-task losses** 5.4%		Short stops	0.2%
				Speed losses / Idling	5.2%
		Time-on-task 32.4%	**Instruction** 3.2%	Revision	1.9%
				New Content	1.3%
			Application 17.4%	Group work	10.9%
				Individual written	4.6%
				Individual tablet	1.9%
			Assesment 11.8%		11.8%

Another interesting fact gleaned from the analysis is that, although a lot of literature is spent on classroom management, internal interruptions constitute only 0.7% of the school day. The field notes indicate that all of the off-topic discussions had been initiated by the teacher during on-task learning time.

Looking at the time-on-task, an interesting data point is that only 1.2% of the 1080 minutes observed was spent on introducing new content – less than 13 minutes and 4.0% of total time-on-task observed.

The analysis was presented to the teacher of the school and received an overwhelmingly positive response with 93.2% of teachers indicating that they had thought of improvement ideas after the presentation, and 90.4% saying that they think their school could benefit from further such studies (Doyer & Bean, 2023).

Although the combined teacher data gave more observations to analyse to get the most representative view of the data, it was interesting to note the variations between the days of the three different teachers.

The field notes described the first day as a "traditional" teaching day following the formula of revision, teaching of new concepts and application. The second observed day consisted only of maths assessments. This day is therefore referred to as an "assessment" day. The last day was spent on facilitating group work with the teacher walking between groups supervising and guiding and the learners engaged in collaborative and creative planning. This day is described as a "group work" day.

The analysis highlighted some interesting observations when comparing the structure of the three different days. As can be seen in Table 2, the traditional day had the least available time-on-task. This was due to the varied activity types within the lesson plans, creating the need for frequent instructions and in-class changeovers of books and equipment. The traditional day also had the highest time-on-task losses, which were observed during written individual (workbook) activities, which the field notes indicated were a challenge for the learners to stay engaged with.

The two other days had fewer changes of activities during the periods, and thus more time was available for on-task activities. The "assessment" day contained prepared assessments and thus the learners knew what to expect and few instructions were necessary. The time-on-task losses were due to many students finishing the assessment early and thus "idling" for the rest of the test period. The "group work" day, called "Fantastic Friday", required learners to continue with a second-language group project of creating a play about cyber safety. This day saw the highest time-on-task engagement levels, with relatively few instructions needed, but time also spent on some other work and arrangements.

Table 2: Comparison of the time-on-task of three different school days

		Available time-on-task	Actual time-on-task	Lost time-on-task
Traditional day	in minutes	111.13	73.37	37.76
	as % of school day	30.9%	20.4%	10.5%
Group work day	in minutes	129	129	0
	as % of school day	35.8%	35.8%	0.0%
Assessment day	in minutes	168.1	147.9	20.2
	as % of school day	46.7%	41.1%	5.6%

The field notes revealed another interesting observation: although the group work teacher spent little time on instructional teaching, the learners were fully engaged in learning. The traditional day teacher was most actively teaching and facilitating yet had the lowest time-on-task result, with the lowest engagement levels. This poses the research question of what the relationship is between the amount of teaching activity and the amount of learning activity.

Although the analysis of the teaching days is useful for teachers to identify improvement opportunities in how they spend their time, productivity in schools is ultimately measured by the amount of learning that takes place. The next section thus investigates how much of the school day a learner spends on task.

Results and discussion: a day in the life of a grade 5 class

The secondary data set also contained a set of observations of the activities engaged in by one class of grade 5 learners during the course of one school day.

Although the school closures during the Covid-19 pandemic made further observations impossible, this data set could be read together with that of the teachers to gain a broader understanding of the school's time-on-task levels.

The grade 5 class observations covered 11 periods and a total of 360 minutes and consisted of 84 separate observations. The data was coded into the TOTA template, enabling another set of descriptive statistics to be produced.

This analysis indicated that 38.4% of the school day was spent on-task, almost half of time scheduled as academic time (80.1%). As can be seen in Table 3, the three biggest losses of the scheduled academic time were as follows:

1. Speed loss / idling due to learners not being kept busy while others are still finishing tasks, as well as learners not participating in a double swimming lesson.
2. Set-up academic (in-class configuration), which included a double swimming lesson requiring learners changing.
3. Set-up logistics (class changeovers).

Table 3: Breakdown of learner school day using the TOTA model

Scheduled non-academic time 19.7%			**Events** 0.0%	Routine	0.0%
				Non-routine	0.0%
			Breaks 8.1%	Formal	7.3%
				Informal	0.8%
			Set-up allowance 11.6%	In-class configuration	3.1%
				Class changeovers	8.5%
Scheduled academic time 80.1%	**Availability losses** 23.6%	**Interruptions 3.1%**	**External** 1.4%	Administrative	0.0%
				"Drive-by"	0.0%
				Maintenance	0.0%
				Resource availability	1.5%
			Internal 1.7%	Discipline issues	1.7%
				Off-topic discussions	0.0%
		Set-ups 32.1%	**Set-up logistics** 27.9%	Class changeovers	7.3%
				In-class configuration	9.0%
			Set-up academic 4.2%	Progress monitoring	0.4%
				Work instructions	3.9%
				Other	0.0%
			Set-up non- academic (administration)		0.0%
	Available academic time 56.5%	**Time-on-task losses** 18.1%		Short stops	0.0%
				Speed losses / Idling	18.1%
		Time-on-task 38.4%	**Instruction** 1.4%	Revision	1.4%
				New Content	0.0%
			Application 36.9%	Group work	7.6%
				Individual written	10.2%
				Individual tablet	19.1%
			Assesment 0.1%		0.1%

When combining all 4 observed days, thus 1440 minutes, 33.9% was spent on-task, with 99.0% of the on-task time used for revision and application of concepts previously introduced. The data were subsequently analysed to determine which of these time-on-

task activities were the most successful in engaging the learners. Counting the number of learners on task during the learning activity at two- to three-minute intervals, produced a percentage of on-task engagement.

Although the secondary data would need to be supplemented by more representative observational data, this analysis indicated engagement levels during the four days of classroom observations. The best engagement (100%) was achieved through group work, individual application of learning on tablets, and interactive revision (teacher asking the learner group questions to test for retention and understanding). The formal assessment, as well as group work, achieved only 64% engagement, with the physical education lesson (swimming) showing only a 31% engagement level due to non-participating learners, as well as speed differences amongst the swimmers, causing waiting time for the faster swimmers. The instructing of new concepts achieved an 83% engagement level, and the field notes indicate that the teacher used a combination of instructional methods, including audio-visual material.

The descriptive analytics described here thus demonstrated how systematic, quantified classroom observational data can be analysed using the TOTA model. Analysing the secondary classroom observation data set through the TOTA model, showcased what kind of information the model could produce.

Conclusion

To increase productivity in the education sector, efficient use of available teaching time must be ensured. This means that from a school manager's perspective the teaching programme must be planned and implemented in such a way that disruptions and interruptions to classroom teaching activities are avoided.

From an individual teacher's perspective, good classroom management competencies are essential to ensure optimal use of teaching time. For this to occur, good planning and thorough preparation are required. In this regard the TOTA model is a valuable tool that school managers and teachers can utilise to diagnose unnecessary time losses so that time-on-task can be improved. It therefore has implications for the instructional and transformational leadership practices of educational leaders.

With Society 5.0 and Industry 4.0 unfolding, the education sector needs to play an agile, efficient, and effective upstream role to the workplace. By using the TOTA model to analyse and diagnose the school day, practical steps can be taken to improve productivity at grass roots level.

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