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# Generic Early Warning Signals for Program Student Withdrawals: A Complexity Perspective Based on Critical Transitions and Fractals

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**Abstract :** Complex systems exhibit universal characteristics as they near a tipping point. Among them are common generic early warning signals which precede critical transitions. These signals include: critical slowing down in which the rate of recovery from perturbations decreases over time; an increase in the variance of the state variable; an increase in the skewness of the state variable; an increase in the autocorrelations of the state variable; flickering between different states; and an increase in spatial correlations over time. The presence of the signals has management implications, as the identification of the signals near the tipping point could allow management to identify intervention points. Despite the applications of the generic early warning signals in various scientific fields, such as fisheries, ecology and finance, a review of literature did not identify any applications that address the program student withdrawal problem at the undergraduate distance universities. This area could benefit from the application of generic early warning signals as the program withdrawal rate amongst distance students is higher than the program withdrawal rate at face-to-face conventional universities. This research specifically assessed the generic early warning signals through an intensive case study of undergraduate program student withdrawal at a Canadian distance university. The university is non-cohort based due to its system of continuous course enrollment where students can enroll in a course at the beginning of every month. The assessment of the signals was achieved through the comparison of the incidences of generic early warning signals among students who withdrew or simply became inactive in their undergraduate program of study, the true positives, to the incidences of the generic early warning signals among graduates, the false positives. This was achieved through significance testing. Research findings showed support for the signal pertaining to the rise in flickering which is represented in the increase in the student's non-pass rates prior to withdrawing from a program; moderate support for the signals of critical slowing down as reflected in the increase in the time a student spends in a course; and moderate support for the signals on increase in autocorrelation and increase in variance in the grade variable. The findings did not support the signal on the increase in skewness of the grade variable. The research also proposes a new signal based on the fractal-like characteristic of student behavior. The research also sought to extend knowledge by investigating whether the emergence of a program withdrawal status is self-similar or fractal-like at multiple levels of observation, specifically the program level and the course level. In other words, whether the act of withdrawal at the program level is also present at the course level. The findings moderately supported self-similarity as a potential signal. Overall, the assessment of the signals suggests that the signals, with the exception with the increase of skewness, could be utilized as a predictive management tool and potentially add one more tool, the fractal-like characteristic of withdrawal, as an additional signal in addressing the student program withdrawal problem.

**Keywords :** critical transitions, fractals, generic early warning signals, program student withdrawal
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